### GENESIS INCORPORATED TROY MINE

### **REVISED RECLAMATION PLAN**

Submitted by:

Genesis Inc. P.O. Box 1660 Troy, Montana 59935

October 2005 - Revised March 2006 -

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**GENESIS INCORPORATED** 

TROY MINE

REVISED RECLAMATION PLAN

1.0 INTRODUCTION

This revised reclamation plan describes reclamation elements for final closure of the Troy

Mine located near Troy, Montana (Figure 1-1 and Exhibit A). The Troy Mine is owned by

Genesis Inc., a subsidiary of Revett Silver Company. This plan provides detailed

descriptions of all elements needed for final reclamation. Although dependent on metal

prices and other factors, Genesis Inc. (Genesis) plans to operate the mine for approximately 4

to 5 years prior to cessation of mining.

1.1 PURPOSE

The purpose of this reclamation plan is to:

1. Update and revise the reclamation plan to reflect modifications presented in the

December 2000 Revised Reclamation Plan and subsequent responses to agency

comments provided in May 2004 and March 2005. This revision also addresses

current conditions that are not as anticipated in the 1979 EIS, mine operating permit,

and reclamation plan. Conditions that have changed since the 1979 planning and

permitting documents include:

• The presence of toe ponds at the perimeter of the tailing facility dike;

• Borrow areas adjacent to the tailing facility and mill site to provide a source

of subsoil material for reclamation;

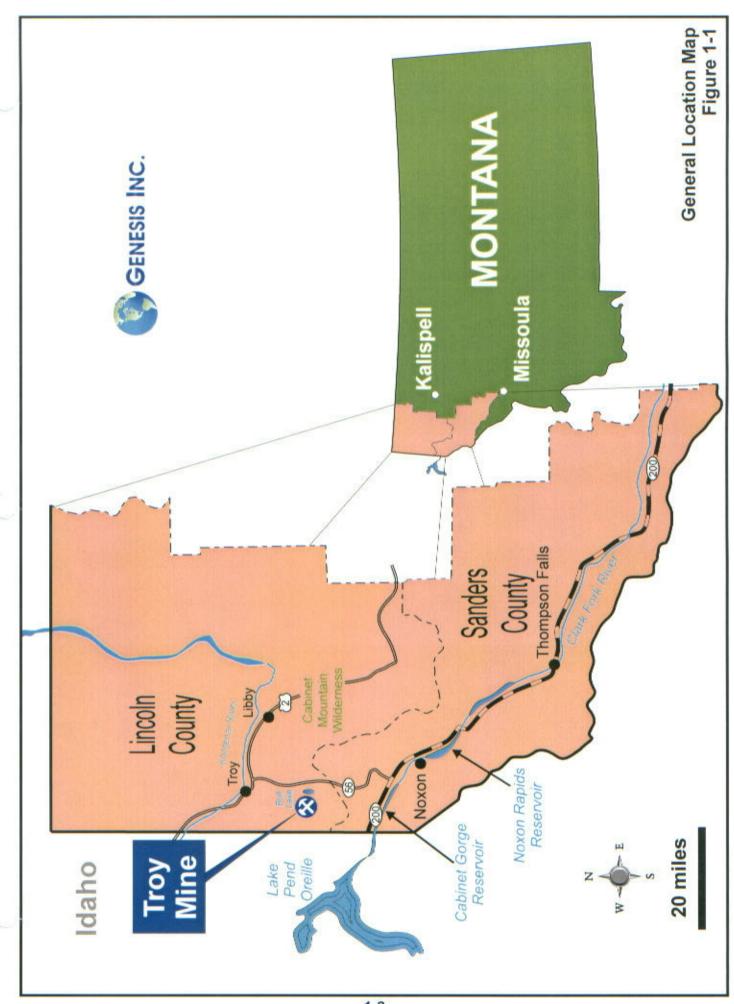
• The addition of the EP-1 pumpback well; and

The post closure retention of 13 acres near the Quonset Hut as industrial land

use.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 March 17, 2006

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2. Update the reclamation plan based on knowledge and data acquired over the course of mine operation and interim shutdown (e.g. volume and quality of mine water and performance of revegetation test plots).

3. Consolidate reclamation plans for a review of reclamation bonding by the Montana Department of Environmental Quality (MDEQ).

4. Describe reclamation plans for a review of long-term uses of land managed by the US Forest Service – Kootenai National Forest (KNF).

Proposed revisions to the original 1976 Reclamation Plan including revisions made in 1978, 1979 and 1996 are summarized in Table 1-1.

### 1.2 GOALS AND OBJECTIVES

Goals of the reclamation plan are to:

1. Re-establish and improve wildlife habitat;

2. Protect groundwater quality and surface water quality in Fairway, Stanley, and Lake Creeks;

3. Protect air quality in the surrounding areas;

4. Provide public access to Federal lands; and

5. Protect public health and safety by removing potential hazards, primarily mine openings and facilities.

To achieve these goals, specific reclamation objectives have been established (Table 1-2).

TABLE 1-1. PROPOSED REVISIONS TO THE RECLAMATION PLAN TROY MINE

	<b>Reclamation Element</b>	Purpose of Revision
Revegetation	Modified Soil Capping of Impoundment	<ul> <li>Utilize borrow soil for 18" soil cover on impoundment surface to provide best media for forest revegetation.</li> </ul>
	Soil Borrow Areas Near the Impoundment."	Provide material for capping of impoundment.
	Modification of Seed Mixes	<ul> <li>Emphasis on native species.</li> <li>Reflect species/cultivars currently available.</li> </ul>
	Addition of Wetlands and Open Water	<ul><li>Increase post-operation habitat diversity.</li><li>Provide wetland mix.</li></ul>
	Weed Control	<ul> <li>Incorporate weed prevention into project layout, design, alternative evaluation and decisions and include weed prevention measures, including project inspection and documentation in operation and reclamation plans.</li> <li>Prevent conditions favoring weed establishment, minimize bare soil conditions and reestablish vegetation on bare ground caused by project disturbance.</li> </ul>
	Decant Ponds	Capture storm-water runoff from impoundment
	Toe Ponds	Maintain habitat value of ponds. Capture dike runoff and groundwater

TABLE 1-2. TROY MINE RECLAMATION OBJECTIVES

Goal	Objectives
Re-establish wildlife habitat.  Protect groundwater quality and surface water quality in Fairway, Stanley, and Lake Creeks.	<ul> <li>Reclaim disturbed lands to comparable utility to surrounding lands.</li> <li>Increase habitat diversity beyond that proposed in the original reclamation plan.</li> <li>Provide wildlife security consistent with KNF road use and access objectives.</li> <li>Monitor and maintain good surface water quality.</li> <li>Divert the flow of mine water from the underground workings to the tailing facility.</li> <li>Minimize the use of public land for location of water treatment facilities long-term and for the disposal of mine waters</li> <li>To the extent practicable, select water management components that minimize the amount of facilities that are needed after reclamation (e.g. minimize requirements for pipelines, power lines, and buildings).</li> <li>Achieve containment of tailing facility stormwater runoff and, to the extent practicable, containment of primary dike seepage within the</li> </ul>
	facility.  • Provide water quality monitoring to measure reclamation success.
Protect air quality in the surrounding areas.	Control dust through reclamation of disturbed areas.
Provide public access to federal lands.	Maintain roads as directed by USFS-KNF.
Protect public health and safety by removing potential hazards, primarily mine openings and facilities.	Seal, secure, and reclaim mine openings.
	Remove mine and mill facilities

1.3 SCHEDULE

Reclamation of the Troy Mine will be accomplished in three phases: pre-closure, closure,

and post-closure. The final phase of mine operation (pre-closure phase) will allow time to

evaluate and modify as necessary reclamation elements (primarily short-term water

management plan) prior to closure of the mine.

During the mine closure phase (estimated to require 2 years after cessation of mining) all

facility removal and regrading, revegetation, and components of the water management plan

will be conducted.

1.4 BACKGROUND

The Troy mine area was initially investigated for mineral potential during the 1960's by

Beartooth Exploration Company, a subsidiary of Kennecott Minerals. After initial diamond

drilling and an exploration adit (South Adit) were completed in 1969, the property was

placed on the market. ASARCO Incorporated completed a lease arrangement with

Kennecott in 1973. The Montana Department of State Lands and United States Forest

Service - Kootenai National Forest conducted an EIS on Asarco's proposed mining and

reclamation plans and subsequently operating permits were issued to Asarco in 1979. The

operating permit also incorporated a basic reclamation plan and bonding requirement of

\$2.75 million. Asarco established the bond and the bond has been in place since 1979.

Development of the underground copper/silver mine started in 1979 and included

construction of the mining and milling facilities, tailing facility, tailing and reclaim water

pipelines, and associated roads and utilities. Mine development was completed and

production of ore concentrate started in 1981. During production, the mine produced

approximately 8,500 tons/day of ore. In April 1993, Asarco suspended mining and milling

and placed the Troy Mine on care and maintenance status due to low metal prices. From

1993 through 2004, the primary activities at the mine have included:

• Care and maintenance of equipment and facilities;

• Reclamation of portions of the tailing facility (primarily soil placement and seeding

March 17, 2006

and tree planting of the embankment and portions of Impoundment Section II);

1-6

- Evaluation of revegetation success;
- Testing of various methods for reclamation of the tailing;
- Geotechnical monitoring of the tailing facility;
- Monitoring of water quality and aquatic biology of Stanley, Fairway, and Lake Creeks;
- Monitoring of groundwater in, and adjacent to, the tailing facility;
- Initiation of studies to determine the transport routes and fate of mine water disposed in the tailing facility;
- Preliminary assessment of tunnel-plugging methods;
- Evaluation of water treatment methods;
- Evaluation of mine flooding during a period of pump shutdown; and
- Evaluation of fate and transport of metals in mine water discharge at the tailing facility.

Genesis Inc. purchased the lease agreement from Asarco for the Troy Mine and the nearby Rock Creek Project in October 1999 and purchased the overall property from Kennecott in March 2000. In November 2004 Genesis Inc. re-initiated mining which will focus on development of the East Ore Body portion of the mine, which will be the main area of mining for the remaining life of the mine.

The 1979 operating permit for the mine incorporated a basic reclamation plan and bonding requirement of \$2.75 million that has been in place since 1979. The operating permit and bonding for the mine was held by Asarco until early 2005 when Genesis Inc. obtained the necessary financial assurance under its own name. During the fall of 1999, the Montana Department of Environmental Quality (MDEQ) notified Asarco that a review of the reclamation bond was underway and would most likely involve a substantial increase in the bonding requirement for the Troy Mine. In October 1999, the MDEQ notified Asarco that a substantial bond increase (from the previous amount of \$2.75 million to over \$10 million) would be required if the original 1976 reclamation plan remained in place. Asarco, working with Genesis Inc. submitted a draft revised reclamation plan to MDEQ for review and

consideration during MDEQ's bond review in January 2000. The MDEQ determined that an

interim reclamation bond of \$10.5 million was required during the reclamation plan review

process. This bond was established by Asarco and revision of the reclamation plan

continued with submittal of a revised reclamation plan in December 2000. Agency review of

the revised plan resulted in comments provided to Genesis in May 2004 and March 2005 and

subsequent responses by Genesis.

1.5 MINERAL AND SURFACE OWNERSHIP

1.5.1 Mineral Lands

Mineral lands associated with the Troy Mine include both private land (420 acres from 21

patented claims) and unpatented land (3,760 acres from 188 claims). The patented land is

associated with the actual ore reserve for the Troy Mine. Exhibit B shows the location of the

patented and unpatented mining claims controlled by Genesis Inc. The plant site is on

unpatented mining claim land owned by the USFS. The operating permits and associated

special use permits allow the use of this land during mining operations (Table 1-3). The

KNF has indicated a preference for removal of facilities from USFS land to the extent

practicable during final reclamation.

**1.5.2 Fee Land** 

The location of fee or private land that is owned by Genesis Inc. is presented in Exhibit B.

The tailing facility and associated disturbances lie completely within the 780 acres of private

land. The tailing pipeline and the powerline are within USFS land and private land owned

by Genesis Inc. and other private landowners.

1.6 LAND USE

The Kootenai National Forest is managed for multiple uses by the USFS under the KNF

Forest Plan. Private land in the area is primarily managed for forest production, recreation

and mining. Historic use of private property in the tailing facility area was tree farming.

1.7 PERMITS

A list of permits associated with the Troy Mine operations is attached as Table 1-3.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 1-8 March 17, 2006

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### TABLE 1-3. LIST OF PERMIT DOCUMENTS - TROY MINE

### **ROAD USE PERMITS**

D	A	1	Γ	F.
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11/6/1979 USFS permit to use Lower Stanley Creek 'Road #7148 (from center section 7, T29n, R33V

0.98 miles

and Stanley Creek Road #4626 (from Road #7148 to NW 1/4 Section 25. T29N, R34W

4.14 miles

USFS Permit to use Road #398 for 2.8 miles; #4628 for 4.4 miles; #4629 for 0.7 miles for hauling timber

8/15/1996 from private lands in Sections 5 and 6, T28N, R33W and Sections 35 and 36, T29N, R34W

When reconstruction on Road #4628 is complete, the existing non-system shortcut road from the beginning

of rock pit in section 7 and ending in Section 5 will be closed on both ends by berm

Letter of Agreement modifying the Road Use Permit issued to ASARCO on 5-5-98 to include FSR #384E

10/19/1998 in addition to FSR #384 and #7148.

### 310 PERMIT

**DATE** 

Lincoln County Conservation District, approved LI-10-1-80. Project completed 9-25-81 (precast concrete

11/18/1980 bridge over Stanley Creek

### AIR QUALITY PERMITS

**DATE** 

1/15/1982 Permit # 1690, Permit for a wet scrubbing system to control emissions from the secondary crusher area

11/10/1982 Permit #TW-4, Permit to burn wood byproduct trade waste. Renewable each January

### **BORROW PIT LETTER**

DATE

Letter from John Righten, District Ranger, KNF, authorizing use of the borrow pit below the mine site. No

1/22/1991 additional bond required, but there is a charge of \$0.75/cubic yard for the materia

### DRIVEWAY AND APPROACH APPLICATION AND PERMIT

**DATE** 

Permit from the State of Montana, Department of Highways. Permission to construct an approach from

12/18/1978 Route 56 at milepost 24.6.

### WATER RIGHT PERMITS

## PRIORITY DATE 3/30/1978 18093-76D 3/30/1978 18094-76D 3/30/1978 18095-76D 1/11/1982 40659-G76D 1/11/1982 40660-G76D 6/3/1983 7/6/1990 75078-G76D

2.0 RECLAMATION HISTORY

To the extent possible, consistent with operational requirements, final reclamation of

disturbed areas has proceeded during operations. Areas that cannot undergo final

reclamation until after permanent mine closure have been temporarily stabilized. This

section describes areas that have undergone final reclamation; currently reclaimed areas are

shown on Exhibit C. A summary of reclamation status and disturbed acres is contained in

Table 2-1.

2.1 EXPLORATION AREAS

Exploration areas have been handled through separate reclamation plans and subsequent

bonding through out the life of the project. All exploration areas have been reclaimed and

the corresponding bonding has been released except for bonding of 2004 drilling pads.

Genesis Inc. requested and received a partial bond release from the 2004 exploration

program. These funds were rolled over to cover the summer 2005 drilling program.

**2.2 ROADS** 

Roads used to access the plant site and upper adits are USFS roads that were in place prior to

construction of the mine. The main access road up to the plant site was paved in 1981 to

reduce the maintenance requirements for the Mine. Cut and fill areas were reseeded during

mine construction.

2.3 DEVELOPMENT ROCK

Development rock piles from advancing the underground service and conveyor adits were

placed near the adit portals. This development rock was used to construct the patio areas

around the Secondary Crusher, Mill and Shop/Office areas of the plant site. Some of the

rock was used for road base for the main access road during the construction phase of the

mine in 1980. Most of the development rock is beneath pavement or buildings. Final

reclamation of these areas will be completed after permanent mine closure.

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TABLE 2-1. TROY MINE DISTURBANCE ACREAGE

Disturbed   Area (Acres)   Final Disturbed   Area (acres)										
Tailings Impoundment   Cell   73   73   82.77   0   8					Remaining Area to					
Cell 1										
Cell 1	Description	Area (Acres)	Area (acres)	(acres)	(acres)					
Cell 1	T 12 1 4									
Cell 2         89.12         89.12         30.49         8           Cell 3         114.99         123.87         0         12           Decam Ponds         7.31         7.31         0           Reclaim Pump & Pond         0.8         0.8         0           Maintenance Sump         1.09         1.09         0           Tailings Facility Roads         10.55         10.55         0           Impoundment Dike - w\o roads         42.07         42.07         42.07           Toe Ponds-all         4.95         4.95         0           Main Topsoil Stockpile - Toe Ponds         43.56         43.56         43.56           Main Topsoil Stockpile - Cell 3         0.45         0.45         0.45           Borrow Pit East         5.23         10.57         2.73           Borrow Pit Cell 3         0         10.79         0         1           Borrow Pit Cell 3         0         10.79         0         1           Borrow Pit Cell 3         0         10.79         0         1           Subtotal         394.73         429.34         117.49         32           Plant Site Area         North Percolation Pond         1.46         1.46	· .	72.17	02.77	0	00.00					
Cell 3				,	80.88					
Decant Ponds					87.94					
Reclaim Pump & Pond   0.8   0.8   0.8   0   Maintenance Sump   1.09   1.09   0   0   Tailings Facility Roads   10.55   10.55   0   1   1.055   10.55   0   1   1.055   10.55										
Maintenance Sump										
Tailings Facility Roads         10.55         0           Impoundment Dike - w\o roads         42.07         42.07         42.07           Toe Ponds-all         4.95         4.95         0           Main Topsoil Stockpile - Toe Ponds         43.56         43.56         40.31           Topsoil Stockpile - Cell 3         0.45         0.45         0.45           Borrow Pit East         5.23         10.57         2.73           Borrow Pit N.E.         1.44         1.44         1.44           Borrow Pit Cell 3         0         10.79         0         1           Subtotal         394.73         429.34         117.49         32           Plant Site Area           North Percolation Pond         1.46         1.46         1.46         1.46           South Percolation Pond         0.56         0.56         0         0           Old Warehouse Pad         3.86         3.86         0         0           Stormwater Pond         1.53         1.53         0         0           Office and Shop Pad         11.6         11.6         11.6         0         1           Mill Pad         10.8         10.8         0         0	*									
Impoundment Dike - w/o roads										
Toe Ponds-all	·			,						
Main Topsoil Stockpile - Toe Ponds					0					
Topsoil Stockpile - Cell 3				,						
Borrow Pit East   5.23   10.57   2.73     Borrow Pit N.E.   1.44   1.44   1.44     Borrow Pit Cell 3   0   10.79   0   1     Subtotal   394.73   429.34   117.49   32     Plant Site Area					0					
Borrow Pit N.E.   1.44   1.44   1.44   1.44   1.44   Borrow Pit Cell 3   0   10.79   0   1   1   11.74   32   117.49   32   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.66   0   33.67   0   33.67   0   33.67   0   33.67   0   33.67   0   33.67   33.67   33.67   0   33.67   33.67   33.67   0   33.67										
Borrow Pit Cell 3					7.84					
Subtotal   394.73   429.34   117.49   32			•		0					
Plant Site Area   North Percolation Pond   1.46   1.46   1.46   1.46   South Percolation Pond   0.56   0.56   0   0   0   0   0   0   0   0   0		ŭ		•	10.77					
North Percolation Pond	Subtotal	394.73	429.34	117.49	323.61					
North Percolation Pond	DI LOLL									
South Percolation Pond   0.56   0.56   0		1.46	1.46	1.46						
Old Warehouse Pad   3.86   3.86   0										
Stormwater Pond										
Office and Shop Pad         11.6         11.6         0         1           Mill Pad         10.8         10.8         0           Water Tank and Access Rd         1.08         1.08         0           Office\Mill Corridor Cut Slope         3.03         3.03         3.03           Subtotal         33.92         33.92         4.49         2           Mine Area         11.71         11.71         9.19           South Portal         3.57         3.57         0           Subtotal         15.28         15.28         9.19           Utility Corridor           Pump Station (near Fairway Ck)         0.91         0.91         0           Tailings line footings         0.67         0.67         0           Borrow Pit USFS N of Office         2.10         3.00         0           Subtotal         3.68         4.58         0.00           Roads           FS 4626 HY 56 to mine         27.61         27.61         0.00           FS 4626C to Perc Ponds         1.29         1.29         0.00           FS 4626F to North Portal         1.14         1.14         0.00           FS 4626A628 Mi										
Mill Pad       10.8       10.8       0         Water Tank and Access Rd       1.08       1.08       0         Office\Mill Corridor Cut Slope       3.03       3.03       3.03         Subtotal       33.92       33.92       4.49       2         Mine Area         North Portal       11.71       11.71       9.19         South Portal       3.57       3.57       0         Subtotal       15.28       15.28       9.19         Utility Corridor         Pump Station (near Fairway Ck)       0.91       0.91       0         Tailings line footings       0.67       0.67       0         Borrow Pit USFS N of Office       2.10       3.00       0         Subtotal       3.68       4.58       0.00         Roads         FS 4626 HY 56 to mine       27.61       27.61       0.00         FS 4626C to Perc Ponds       1.29       1.29       0.00         FS 4626F to North Portal       1.14       1.14       0.00         FS 4626/4628 Mill Site to South Portal       25.37       25.37       0.00         FS 4628C to South Portal       0.89										
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Subtotal   33.92   33.92   4.49   2				,	-,,,					
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FS 4626 HY 56 to mine       27.61       27.61       0.00         FS 4626C to Perc Ponds       1.29       1.29       0.00         FS 4626F to North Portal       1.14       1.14       0.00         FS 4626/4628 Mill Site to South Portal       25.37       25.37       0.00         FS 4628C to South Portal       0.89       0.89       0.00	Subtotal	3.00	4.30	0.00	7.30					
FS 4626 HY 56 to mine       27.61       27.61       0.00         FS 4626C to Perc Ponds       1.29       1.29       0.00         FS 4626F to North Portal       1.14       1.14       0.00         FS 4626/4628 Mill Site to South Portal       25.37       25.37       0.00         FS 4628C to South Portal       0.89       0.89       0.00	Roads									
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Subtotal 50.50 50.50 0.00					0.00					
	Subtotal	30.30	50.30	0.00	0.00					
TOTAL 503.91 539.42 131.17 35	TOTAL	503 01	530 //2	131 17	358.67					

2.4 UNDERGROUND MINE OPENINGS AND FACILITIES

There are six adits that access the mine (three at the North Adit patio, two at the mill, and

one at the South Adit patio). Reclamation has only been initiated on the North Adit patio.

The area around the North Adit has been reclaimed to the extent possible considering future

operating requirements. A large surface stockpile of low-grade ore has been removed and

processed and the area has been recontoured and replanted. The dump slope below the North

Adit has been revegetated to the extent possible by seeding and tree planting. Table 2-2

summarizes tree planting activities conducted to date at the Troy Mine. A total of 3,750 tree

seedlings were planted in the North Adit area in 1997 and 1999 (Stephens Timber

Consulting, 2000a).

2.5 MILL AND PLANT SITE

A relatively small amount of reclamation activity has occurred around the plant site. Most of

the area is currently used for mining and ore processing operations. An area just south of the

surface fuel storage tank and an area along the road between the mill and office areas have

been completely reclaimed with recontouring, seeding and tree planting activity. All

underground fuel storage tanks were removed in 1996 under the guidance of the State UST

program. Reclaimed areas are shown on Exhibit C.

2.6 UTILITY CORRIDOR

The utility corridor consists of the tailing lines (two, 8-inch steel pipes), a buried reclaim

water line (10 to 12-inch steel pipe), and the 115 kV electrical power line. After construction

of these facilities in 1980, the disturbed area was seeded with a grass mix. Several tree and

forb species have invaded the narrow corridor and small trees have been thinned out as

required for pipeline and power line maintenance over the past two decades.

2.7 TAILING FACILITY AREA

The surface of the tailing facility cannot be reclaimed until after completion of mining,

milling and tailing deposition activities. Future tailing deposition will occur in all three cells

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Table 2-2. Troy Unit

# Historical Tree Planting Activities

	Plan	Planting Date: Spring 1995	ring 1995	Planting Date: May 1996	May 1996	Planting Date: May 1997	day 1997	Planting Date: Oct 1997	11997	Planting Date:	Planting Date: April & May 1998
	Ires	Irre Species 1	Innes ( Acce	Inca Species	Irees (Acte	Irea Species Trees/Acre	Itees/Acre	Irea Species	Trens / Acre	Inte Species	Ilees/Acre
Talling Impoundment Dam Eace	Pen	Ponderosa Pine White Pine	400	Ponderata Pine	300	Ponderosa Pine White Pine	900	Ponderosa Pine White Pine	250	Ponderosa Pine White Dine	700
						Western Larch		Douglas fir	0.00	Douglas fr	88
350							,			A. Carrier	
Total Agres 60	Tota	Total Acres	9650	Total Acres	650 Interplanting	Total Trees. Total Acres	3500	Total Arres	2000 Interplanting	Total Acres	25
Uncapped Tailings in Section II					May 1036						
				Iree Species	Itees / Acte						
				Scotch Pine Ponderosa Pine	300						
Total Trees.				White Pine	100						
				Total Trans.	2600						
				Total Acres	5						
Capped test plot in Section II	Plan		1 1997	Planting Date:	Planting Date: April & May 1958	17.	28 1989	Planting Date: November 1999	vember 1999		
	Ites	Men Species 1	lines//octs	Ires Species	Imes/Acre	Irea Species	Irees / Acre	Iren.Species	Irees/Acre		
	Pon	Ponderosa Pine	250	Ponderosa Pine		Ponderosa Pine	230	Ponderosa Pine	92		
	The Control	Dorothe Dr	2.0	Describe Re	901	Longardon and	9 5	Coddebate Warte Ding	5 6		
	Too I	Ledgepoin	2.2	Lodgepole	100	Total Control of the	2	Douglas fir	3 5		
20											
Total Acres 32	Tot tot	Total Acres	20	Total Acres	5000 Interplanting	Total Acres	4570	Total Acres	900		
The section of the se	-	Defendant of	1001	Pleasing Date:	Annual & Mana 1992	Observation Date of		olivetica Catachia	tions or any		
opper Abit Reciamation Site		Iten Species Trees.	Inen/Acr	Ine Species	Ing Species Trens Acre	Iren Species Ires 12	Ines./Acr	Irea Species Ireas Acra	Irens/Acra		
	Eng	Engleman Sprud	100					Engleman Spruce	200		
	Alph	Alpine fir	8					Alpine fir	100		
	Mos	White Pine Mountain Maple	9 00								
	- Blac	Black Cettomwoo	8								
	Willow Black	Willow Black Hawthern	2 2								
Total Trees: 3750											
Total Acres 10	Tota	Total Trees:	3000					Total Trees;	750		
	Tota	Total Acres	10					Total Acres	Interplanting		

of the impoundment. Reclamation activities at the tailing facility have consisted of final

reclamation of the face of the embankment, temporary revegetation on the tailing surface,

testing of alternative reclamation methods, and construction of revegetation test plots to

evaluate the success of various topsoil/subsoil capping layers.

The face of the tailing facility starter dam (or starter dike) was reclaimed (topsoiled and

reseeded) soon after construction was completed. Reclamation of the dike face has

continued as the dam height has grown during operations and currently the approximately 42

acre dike face has been reclaimed. In 1995, 1996, 1997, and 1998 a total of 35,360 tree

seedlings were planted on the dike face.

Soon after interim closure of the mine in 1993, Asarco began tests in conjunction with Dr.

Brian Sindelar to test the feasibility of in-place soil building through fertilizers, soil

amendments, and livestock grazing (Sindelar, 1996). Similar soil-building approaches have

been effective in revegetating areas denuded by drought and/or overgrazing and it was

thought that these methods might be successful in revegetation of tailing. In these tests,

cattle were introduced to the area for the purpose of dispersing seeds, organic matter, and

nutrients to the tailing through their excrement. In addition, chemical fertilizer and soil

amendments were applied to the tailing and the area was irrigated by flood and sprinkler

irrigation. Although this approach has been partially successful, the rate of development of

soils and vegetation achieved by this method would require a long time to achieve

reclamation goals for the Troy Mine.

Three revegetation test plots comprising approximately 30 acres have been established in

tailing facility Cell 2 over the past several years (see Section 3.7). Test Plots A (26 acres)

and B (2 acres) have been reclaimed as follows:

• A 12-inch layer of subsoil from the East Impoundment Borrow Site was placed on the

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raw tailing;

• The soil was planted with a grass seed mixture;

• The area was fertilized and mulched;

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• Approximately 20,400 tree seedlings were planted in the area;

• Over 200 large native trees from the borrow area were transplanted to the test area;

and

• The area was irrigated as needed from the sprinkler irrigation system.

Test Plot C (2 acres) has been reclaimed with similar techniques utilizing an 18-inch deep

topsoil cover obtained from the topsoil stockpile on the west side of the impoundment.

Additional borrow soil placement and revegetation continued on Cell 2 from 2002 to 2004.

Revegetation test plots at the Troy Mine have been monitored by Sindelar (1996) and

Stephens (2000a, 2000b). Monitoring to date has documented results of revegetation trials

on the tailing facility surface. Additional qualitative revegetation monitoring by mine

company personnel and consultants has been conducted periodically to ensure that seeded

areas are providing erosion control. Vegetation trials at the site have shown that tree growth

is better with borrow soil than with the previously stockpiled soil.

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3.0 EXISTING FACILITIES

3.1 EXPLORATION AREAS

As of October 2005, there are no active surface exploration areas associated with the Troy

Mine. All previous exploration areas have been fully reclaimed and reclamation bonding has

been released except for drill pads permitted in 2004.

3.2 ROADS

Primary access to the mine is provided by the upgraded USFS road from Highway 56 to the

plant site that consists of 7 miles of 20-ft wide paved road surface. Access to the North and

South Adits is via the existing USFS dirt road (USFS 4626, see Exhibit A) from the plant

site. Additional mine are roads are shown on Exhibit A.

3.3 DEVELOPMENT ROCK PILES

Development rock piles are located adjacent to adit portals and are described in Sections 3.4

and 3.5. Development rock piles from advancing the underground service and conveyor

adits were placed near the adit portals. These rock piles were used to construct the patio

areas around the Secondary Crusher, Mill and Shop/Office areas of the plant site. Some of

the rock was used for road base for the main access road during the construction phase of the

mine in 1980. Additional development rock piles are located near ventilation adits (Exhibit

A).

3.4 UNDERGROUND MINE OPENINGS AND FACILITIES

A map of the underground workings is included as Exhibit D. Primary mine adits consist of

the service adit and conveyor adits with portals at the plant site (approximate elevation 3,700

feet). Existing facilities and disturbances at the plant site are described in Section 3.5. The

service adit (15 ft by 18 ft) provides access to the main (north) ore body, as does the main

haulage adit. The conveyor adit (10 ft by 14 ft) is approximately one mile in length and runs

parallel to the service adit. All mine water outflows from the mine exit through the service

adit either in a ditch or in a pipe affixed to the back (or roof) of the adit.

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In addition to the service and conveyor adits, there are four ventilation adits at the Troy Mine:

• Three ventilation adits located in the vicinity of the North Portal site (North, East and West Adits) are located above the service/ conveyor adits at an elevation of approximately 4,400 ft in the Stanley Creek drainage. The surface disturbance consists of the North Adit patio area (north, east and west adits) of approximately 12 acres. The development rock pile at the North Adit extends approximately 160 feet down the natural slope from the portal. This fill slope of the North Portal area has been reclaimed as described in Section 2.4. Planned reclamation of the North Adit patio and cut slope are described in Section 4.3 and shown on Exhibit A.

• One ventilation adit portal (South Adit) is located in the Ross Creek drainage at an elevation of approximately 4,320 feet. This is the pre-existing evaluation adit that was developed by Kennecott in the 1960's. The South Adit portal consists of a small patio and rock dump totaling about three and a half acres.

The major underground workings consist of the north ore body (NOB), south ore body (SOB), east ore body (EOB), and ore crushing and conveyance areas. The north and south ore bodies are offset by a fault with the south ore body uplifted approximately 250 feet, relative to the north ore body. Primary ore production from the mine during Asarco's ownership occurred in the NOB and SOB areas. The east ore body has not been mined to any appreciable extent, but is the primary mining target for future ore production from the mine.

### 3.5 MILL AND PLANT SITE

Existing layout of the mill and plant site is shown on Exhibit A. The disturbed area of approximately 34 acres consists of:

- Steel water tank (100 ft in diameter by 50 ft high);
- Mine portal areas (service and conveyor adits, main adit, and the east and west exhaust adits);

- Secondary crusher building (steel frame with metal roof and siding 75 ft by 100 ft by 100 ft high) and associated transfer towers;
- Steel fine ore bin (70 ft in diameter by 80 ft high);
- Mill building (steel frame, metal roof and siding 140 ft by 260 ft by 100 ft high);
- Two 30,000 gal propane tanks (each tank 20 ft by 80 ft);
- Core storage building (steel frame with metal roof and siding 50 ft by 50 ft by 15 ft high);
- Shop facility (portable pre-cast concrete panels (tilt-up) 120 ft by 220 ft by 32 ft high);
- Office/dry facility (portable pre-cast concrete panels (tilt-up) 120 ft by 70 ft by 32 ft high);
- Sewage treatment building (steel frame with metal roof and siding 20 ft by 100 ft by 10 ft high);
- Mill pond (60 ft by 100 ft by 10 ft deep plastic-lined pond);
- Steel tailing thickener tank (225 ft in diameter);
- Lower storage area building (wood frame with metal roof and siding 30 ft by 50 ft by 10 ft high); and
- USFS borrow pit.

Cross sections of the plant area are shown on Figure 3-1.

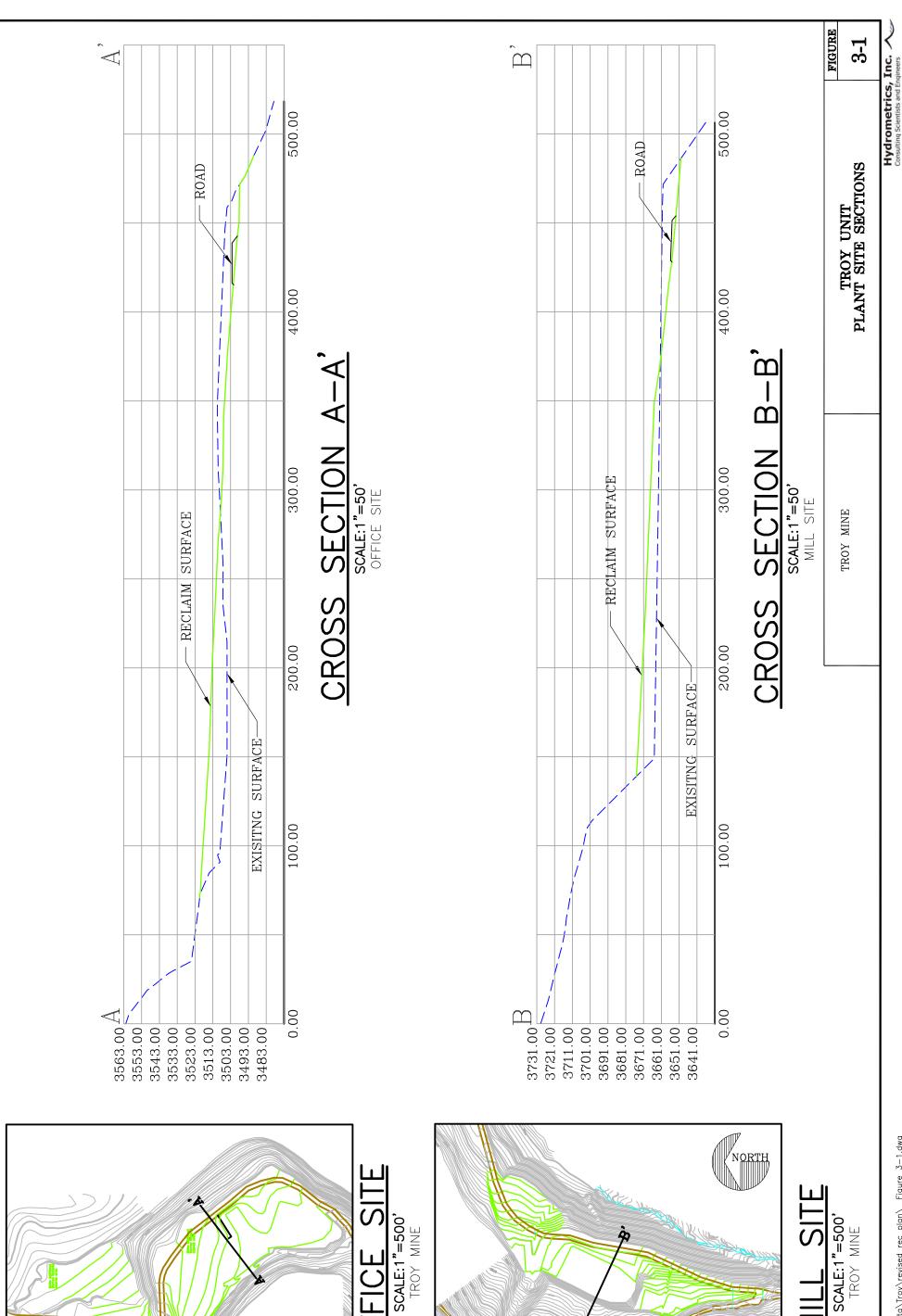
### 3.6 UTILITY CORRIDOR

The utility corridor consists of the tailing lines (two, 8-inch steel pipes), a maintenance sump, a buried reclaim water line (10 to 12-inch steel pipe), and the 115 kV electrical power line (Exhibit A). The maintenance sump is located approximately 1,500 feet south of the reclaim water sump and consists of an unlined, shallow excavation in native materials.

### 3.7 TAILING FACILITY

The existing layout of the tailing facility is shown in Exhibit E. The tailing facility is divided into three sections (Sections I, II, and III) by two divider dikes. These divider dikes are used

to control placement of tailing and water in the impoundment and allow different sections of the impoundment to be managed individually. The tailing facility was originally designed to



Genesis Inc.

contain 60 million tons of tailing and to cover approximately 385 acres. To date, approximately 34 million tons of tailing (primarily milled quartzite) from the Troy Mine have been placed in the impoundment. Currently, the area of disturbance in the impoundment is approximately 345 acres, excluding soil stockpile and borrow sites, with the outer surface of the primary dike (42 acres) reclaimed. Prior to final mine closure, Genesis Inc. intends to mine additional ore from the North, South, and East Ore Bodies. Milling of this ore will generate an additional six to eight million tons of tailing that will be placed the impoundment. The current available capacity will accommodate the additional tailing from the completion of the Troy Mine. At final closure, the surface area of the impoundment will be 345 acres including 42 acres of reclaimed dam face and 303 acres of tailing. Disturbance areas associated with the tailing facility and rest of the mine are listed in Table 2-1.

### Other features of the tailing facility include:

- The Section II reclamation test plots area described in Section 2.7.
- Impoundment site topsoil stockpiles totaling approximately 560,000 cubic yards of salvaged topsoil located on about 44 acres along the western perimeter of the impoundment dike and acting as a dike containing the toe ponds.
- A small stockpile of approximately 1600 cubic yards of topsoil salvaged from decant ponds construction stockpile located east of the impoundment (Table 2-1).
- Two developed and one planned soil borrow sites located on the east side of the impoundment Exhibit E. Four toe ponds located along the perimeter of the toe of the primary dike. In 1982, water began seeping through the impoundment dike and emerged west of the impoundment dike. In 1983, an earthen berm, composed partially of stockpiled topsoil material, was constructed to contain the seepage, natural groundwater, and runoff from the dike face in the four toe ponds. The southern toe pond (toe pond #1) is typically dry. Water from toe ponds 2, 3, and 4 is typically pumped to the impoundment for 2 to 3 weeks during the snowmelt period of each year.
- Three decant ponds (barge ponds) located along the eastern margin of the impoundment. During operation of the mine, these ponds receive tailing water and

storm-water runoff from the impoundment. From the ponds, reclaim water is pumped to the reclaim water pump station and then to the mill for reuse in the milling circuit. During the interim shutdown period and in the initial period following final closure, the decant ponds receive storm-water runoff from the surface of the impoundment and mine water from the underground workings.

- Reclaim water pump station located south of the impoundment near the main mine access road.
- Eleven piezometers to monitor the phreatic surface in the dike.
- Groundwater monitoring system composed of 12 wells, six springs or surface water expressions and the toe ponds proposed for monitoring (Exhibit A and Appendix F).
   Quonset Hut used to store equipment that is located on private ground southeast of the impoundment. This building has a domestic well and septic system.
- Sump and pumping system ("enviro-pump") capturing a spring below toe pond #2.
- Equipment storage area east of the impoundment.
- Local access roads.

Although there have been minor changes in impoundment operation over the last two decades of mining, overall the impoundment facility has functioned as designed and described in the Final EIS and Operating permit for the facility with no long term stability problems or environmental impacts. Groundwater levels within the impoundment are monitored monthly and the impoundment is visually inspected daily by mine personnel and annually by a geotechnical engineer specializing in impoundment construction. To date these inspections indicate no problems with the impoundment stability. Water quality and health of the aquatic ecosystem in Lake Creek adjacent to the impoundment has been monitored quarterly since 1986. Analysis of this long-term water quality data indicates no adverse change in water quality or aquatic health from impoundment operations (Parametrix, 2005).

3.8 CURRENT WATER MANAGEMENT ACTIVITIES

3.8.1 Mine Water

During operations all mine water is used to supply the mill or is used in drilling. Water that

emerges from the service adit flows into the mill. During the interim shut-down mine water

was discharged to the tailing facility (see Figure 3-2).

The relationship of water in the SOB and NOB is discussed in the mine flooding report

attached as Appendix A with this response. The SOB has not historically filled to a level that

resulted in overflow into the NOB. If water rises sufficiently high in the SOB Lower

Quartzite Reservoir the reservoir overflows and drains to the Lower West Reservoir in the

NOB. To date, overflow from the SOB Lower Quartzite Reservoir has only occurred when

water was pumped from the NOB to the reservoir. Therefore, it appears that under steady-

state conditions (no pumping) groundwater inflows and outflows from the SOB area are

approximately equal. Outflows from the SOB area either drain to the surrounding

groundwater system or may drain through rock to the NOB

The East ore body has not been mined to any appreciable extent and therefore groundwater

inflows to the area are minor. During interim closure the EOB was partially flooded and the

water level remained relatively constant and neither pumping of water nor overflows of water

from the area occurred. Groundwater inflow to the EOB has historically drained to the

surrounding groundwater system.

The North ore body partially flooded during interim shutdown. The reservoir created by the

flooded workings was referred to as the Lower West Reservoir. A description of water level

rise in the NOB during the period that pumping was shut down is in Appendix A.

During operations, excess mine water and water from the milling circuit flows via the two 8

inch tailing lines to the tailing facility. At the tailing facility water collects on the eastern

edge of the facility in the decant ponds or the pond in Cell 3. If water is needed in the mill it

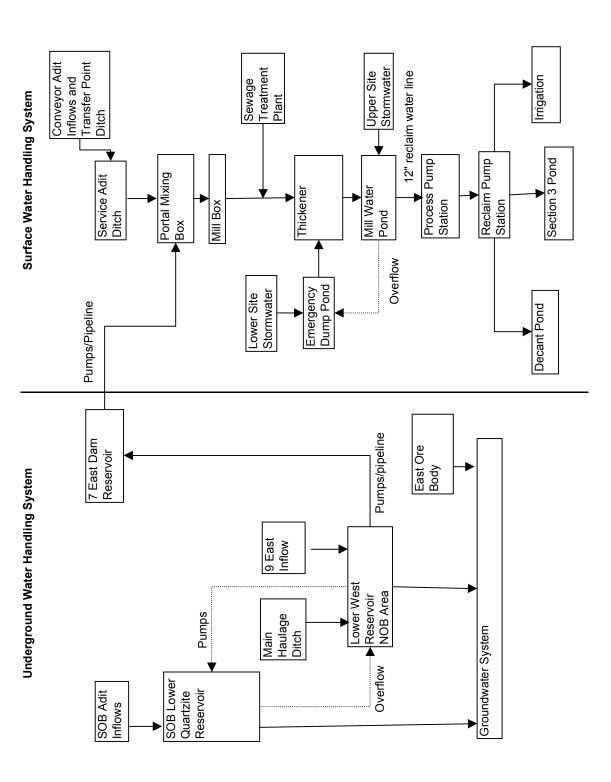
can be pumped back via the return reclaim water line. Clean water from the mine can also be

3-8

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FIGURE 3-2. GENERALIZED FLOW DIAGRAM OF THE TROY MINE WATER HANDLING SYSTEM DURING SHUTDOWN



used to irrigate the tailing for dust control or to assist revegetation. Water at the tailing

facility not returned to the mine or lost to evapotranspiration infiltrates to the valley fill

groundwater system.

Storm-water runoff from the mine and mill site and sewage treatment plant effluent are added

to the mine water either in the mill water pond or thickener.

Groundwater conditions at the decant pond during interim shutdown have been investigated

and reported to DEQ in a 2001 report (Hydrometrics, 2001; Mine Water Plume Location and

Identification Phase 1 Results and Phase 2 & 3 Workplan).

3.8.2 Tailing Toe Ponds and Springs

The four toe ponds located along the perimeter of the toe of the primary dike were installed

in 1983 to contain potential seepage through the embankment, natural groundwater, and

runoff from the dike. The toe ponds are numbered and named toe ponds 1, 2, 3, and 4 from

south to north (Figure 3-2). The southern toe pond (toe pond #1) is typically dry. Toe ponds

2, 3, and 4 usually contain standing water and are often used by moose and other wildlife that

inhabit the area. During the period of interim shutdown, water from toe ponds 2, 3, and 4

was typically pumped to the impoundment at a rate of approximately 500 gpm for 2 to 3

weeks during the snowmelt period of each year. This pumping is done as a safety measure to

ensure that the ponds do not overflow, not because pumping is necessary.

The toe ponds are an expression of the local water table downgradient of the tailing facility.

During operations the water level is higher in the tailing facility, which controls the hydraulic

gradient and rate of groundwater flow to the toe ponds.

Following closure the groundwater gradient will decrease as water levels fall in the tailing

facility after tailing disposal and sprinkling to control dust cease.

A sump and pumping system ("enviro-pump" – located at site S-1 Exhibit A) is employed to

capture groundwater that emerges downhill from the toe ponds. Currently, the system is

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operated by an automatic timer that empties the approximately 500 gallon sump 4 to 6 times per day. Water removed from the sump is pumped to the number 2 toe pond. Quality of pump-back water from the S-1 sump (enviro pump) is shown in Table 3-1. During the summer of 2005, Genesis Inc. decided to disconnect the automatic timer and run the pump continuously. Water from the sump is now pumped continually into toe pond number 2.

During the period of temporary mine closure the enviro-pump system operated throughout the year. During the period following spring recharge the pump cycles on nearly continuously. During the late summer, fall and winter the pumpback system cycles less frequently and removes less water. The enviro-pump collects water from an area near the toe ponds, but does not control the level of water in the toe ponds.

A number of springs occur along the Lake Creek terrace between the tailing facility and Lake Creek. These springs are naturally occurring expressions of groundwater and have been investigated throughout the life of the mine. The S-1 spring was identified because of observed iron staining or deposition. Springs with iron staining occur naturally throughout the Kootenai, Clark Fork, and Lake Creek valleys. These type of springs commonly precipitate iron oxide as redox conditions change when they discharge to the surface. The source of iron is naturally occurring iron in sedimentary beds of Pleistocene lake sediments likely deposited from prehistoric glacial lakes. MDEQ and Asarco have investigated springs along both sides of Lake Creek throughout the life of the Troy operations. This data was originally presented and discussed in the 1990 Groundwater Seepage Report prepared by Ebasco Environmental Services. Iron stained springs are found on both sides of the stream throughout the Lake Creek valley and are clearly natural and not related to the tailing facility. Table 3-1 presents water quality data from selected springs and Exhibit A shows the locations of these sampling sites. Springs S-5 and S-6 shown in Exhibit A have elevated iron concentrations. S-5 and S-6 are naturally occurring springs down stream of the tailing facility and are clearly unrelated to mill process water.

TABLE 3-1. TROY MINE SPRING WATER QUALITY DATA

ness																														2	6		
Hardness																														192			
Hd dı			8.9		8.9	8.9	8.9	8.9			7.1		8.9	7.0				8.9	8.9	8.9	8.9	6.1	6.7		8.9	6.7	6.7	6.7	6.7	8.9	6.5	6.9	
(R) Temp		12	96 44	35	3 44	3 44	3 44			1(	36		39	)2 48				72 44	)3 44	72 44		15 49				53			11 45		77 46	3 53	
b. Zn (TR)	H							600.0		0.001	0.003		0.001	0.002				0.002	0.003	0.002	900'0 1	0.015	0.010		0.007	0.005	900:0		.0 0.011	0 0.039	0.007		0.004
S Turb.		9.5	0.81	0.88 0	0.71	3.7	0.9			5.3	4.4		1.1	9.0				9.6	9.4	2.9	0.4	0 74.0	0 43.0		0 50.0	0 47.0	0 53.0	0 63.0	0 150.0		0 53.0		0.9
C TSS		11.0	23.0	26.0	38.0	19.0	14.0	17.0		1.2	1.9		4.7	11.0				34.0	25.0	1.8	8.0	0.685 (	379.0		1 215.0	241.0	5 517.0	8 611.0		392.0	494.0	2.0	28.
TOC	mdd		< 10	< 10	< 10	< 10	< 10	< 10			< 10		< 10	< 10				< 10	< 10	< 10	< 10	10	10		14	30	25	28				< 10	< 10
TOG	804	1.91	1.93	1.95	1.94	1.91	1.84	1.81		1.66	1.67		1.36	0.48				1.94	16.1	1.85	1.82	1.72	1.75		1.76	1.65	1.71	1.88	2.00	2.07	2.13	1.72	1.70
804	mdd	82.0	0.06	0.06	88.0	82.0	0.69	64.0		46.0	47.0		23.0	3.0				88.0	81.0	71.0	0.99	53.0	99.9		57.0	45.0	51.0	76.0	0.66	118.0	136.0	53.0	50.0
Pb (TR)	mdd	0.007	< 0.001	< 0.005	< 0.001	0.002	0.002	< 0.001		0.011	< 0.001		0.001	0.002				0.002	< 0.002	0.002	< 0.001	0.003	0.004		< 0.001	0.002	0.005	0.002	0.005	0.005	0.003	0.001	0.002
P04	mdd	0.07	< 0.02	< 0.02	< 0.02	< 0.02	80.0	0.02		< 0.05	< 0.02		< 0.02	< 0.02				90.0	< 0.02	0.11	0.05	0.02	0.03		< 0.02	< 0.02	89.0	60.0				< 0.02	< 0.02
Ь	mdd	0.19	> 0.18 <	> 0.18 <	0.24 <		0.16	0.15		> 0.05			0.12	> 50.0				0.30	0.14 <	0.17	0.17	٧	0.50		> 50.0	0.71 <	1.40	98.0				< 0.05 <	> 90.0
Oil/Gr	mdd	1.0	1.0		0.1	1.0	0.1	0.1		> 0.1	> 0.		0.1	>   1.0				0.1	0.	1.0	0''	0.	0		> 0.1	.1	0.	1.0					0
Na	mdd	V	28.00	28.00	26.00 < 1	24.00 < 1	24.00 < 1	V		23.00 < 1	22.00 < 1		10.00	1.20 < 1				25.0 < 1	25.0 < 1.0	23.0 < 1	24.0 < 1		28.0 < 1		30.0	30.0	31.0	33.0 < 1				24.0 < 1.0	0.1 > 1.0
NO2/NO		< 0.05 28	01.0	0.15 28	0.10	0.13 24	0.12 24	0.08 24		0.20 23	0.60		0.37 10	0.12				01.0	0.13	0.10	77 60.0	01.0	0.07		90.09	30.0	8.036	0.06	0.18	90.0	0.17		.2 0.30
TOG	NH3	0.20	0.20	0.26	0.23	0.20	0.23	0.20		-1.00	-0.92		-1.00	-1.00				0.26	0.20	0.23	0.20	-1.00	0.26		0.30	> 0.36	0.34	0.34	0.34	0.23	0.20	-0.21	-0.14
NH3	mdd	1.60	1.60	1.80	1.70	1.60	1.70	1.60		0.10	0.12		0.10	0.10				1.80	1.60	1.70	1.60	0.10	1.80		2.00	2.30	2.20	2.20	2.20	1.70	1.60	0.62	0.72
Mn (TR)	mdd	4.10	3.90	3.80	3.80	2.80	3.30	3.10		) > 77.0	2.60		0.21	0.02				3.80	2.90	3.20	3.20	4.30	5.00		00.9	8.20	7.40	4.60	5.70	7.20	6.40	1.40	1.90
TOG	H	06.0	0.83	0.78	08.0	08.0	92.0	92.0		0.84	0.78		0.52	0.23				08.0	62.0	92.0	92.0	0.83	0.83		98.0	68'0	0.94	16.0				0.79	62.0
Mg	mdd	7.9	7.0	0.9	6.3	6.3	5.7	5.7		6.9	0.9		3.3	1.7				6.3	6.2	5.8	5.7	6.7	8.9		7.2	7.7	8.7	8.2				6.1	6.2
Kjel-N	mdd	1.60	1.60	2.10	1.70	1.80	1.70	1.60		0.41	0.44		0.30	0.10				1.80	1.80	1.70	1.60	2.70	2.30		3.30	3.10	3.40	3.00				0.62	0.72
Ж	mdd	11.0	10.0	10.0	10.0	10.0	6.6	10.0		7.5	6.5		3.6	9.0				10.0	10.0	8.3	10.0	10.0	11.0		12.0	12.0	12.0	12.0	13.0	14.0	14.0	8.6	8.2
HC03	mdd	115	63	911	84	93	104	901		86	83		54	34				81	63	101	122	111	111		144	133	821	110				107	59
Fe (TR)	mdd	6.4	6.1	6.5	8.9	5.9	5.4	5.3		1.2	8.0		9.0	0.1				6.2	6.2	5.5	5.4	12.0	15.0		19.0	29.0	39.0	12.0	58.0	34.0	38.0	1.8	2.9
Cu	mdd	0.005	0.020	0.010	0.020	0.022	< 0.001	< 0.001		0.002	0.012		0.024	0.024				0.002	900.0	< 0.001	0.001	0.008	900.0		900.0	0.001	0.009	0.004	0.014	0.019	0.009	0.002	0.001
10G	Cond.	2.57	2.63	2.53	2.53	2.49	< 2.53	< 2.53		2.46	2.45		2.15	1.78				2.51	2.58	< 2.53	2.52	2.52	2.60		2.60	2.59	2.58	2.56	2.66	2.67	2.74	2.49	2.49
Cond.	soumn	370	430	340	340	310	340			290	280		140	09				320	380	340	330	330	400		402	385	380	360	460	472	550	310	310
ū	mdd	8.0	5.0	7.5	5.0	4.9	5.0	4.8		8.0	5.0		2.3	< 1.0				7.0	4.9	5.3	4.5	5.0	5.0		5.7	5.5	4.0	8.9				3.3	4.8
Cd (TR)	mdd	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	0.001		< 0.001	0.001		< 0.001	< 0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001	< 0.001	< 0.001				< 0.001	< 0.001
DOT	Ca	1.52		> 1.45	1.41	> 1.45	1.36				1.30		> 06.0	> 98.0				1.34	> 1.43	1.32	1.34	> 1.46	> 1.49		> 1.51	> 1.52	> 1.57					1.26	
Ca	mdd	33.0	33.0	28.0	26.0	28.0	23.0	22.0		23.0	20.0		8.0	7.2				22.0	27.0	21.0	22.0	29.0	31.0		32.0	33.0	37.0	33.0				18.0	20.0
C03	mdd		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			1.0		< 1.0	1.0				< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0				< 1.0	< 1.0
Ag (TR)	mdd	< 0.001	< 0.001 <		< 0.001 <	< 0.001 <	< 0.001 <	< 0.001 <		< 0.001	> 10000		< 0.001 <	> 1000				> 0.001 >	< 0.001 <	< 0.001 <	< 0.001 <	< 0.001 <	< 0.001 <		< 0.001 <	< 0.001 <	< 0.001 <	< 0.001 <	< 0.001	< 0.001	< 0.001		> 0.001 >
STAT	Ħ	0 >	0 >	< 0.00	0 >	0 >	0 >	0 >		0 >	0 >		0 >	0 >				0 >	0 >	0 >	0 >	0 >	0 >		0 >	0 >	0 >	0 >	0 >	0 >	0 >	0 >	· 0
DATE ST		11/15/1989 SI	3/30/1989 SI	4/4/1989 SI	4/7/1989 SI	4/19/1989 SI	S/3/1989 SI	S/10/1989 SI	6/26/1989 SI	11/15/1988 S2	3/30/1989 S2	4/4/1989 S2	4/7/1989 S2	4/19/1989 S2	5/3/1989 S2	5/10/1989 S2	6/26/1989 S2	4/7/1989 S3	4/19/1989 S3	5/3/1989 S3	5/10/1989 S3	6/26/1989 S3	7/18/1989 S3	8/2/1989 S3	8/16/1989 S3	9/22/1989 S3	10/18/1989 S3	11/15/1989 S3	3/29/1990 S3	4/19/1990 S3	5/30/1990 S3	5/3/1989 S4	5/10/1989 S4

3.8.3 Domestic Water and Sewage

Domestic water supply at the plant site consists of a two water wells, large water tank

(capacity 300,000 gallons) and buried pipelines. The sewage treatment plant is located next

to the tailing thickener. Sewage treatment includes agitation, aeration, and flocculation with

the effluent introduced to the tailing line at the site box under the tailing thickener.

3.8.4 Storm-water

The majority of the storm-water runoff from the mine and mill site is conveyed to the mill

water pond where it enters the mill water circuit. A small portion of the plant lies below the

elevation of the mill water pond and drains to the storm-water pond located down hill of the

thickener. Water that is collected in the storm-water pond is pumped to the mill water

circuit.

3.9 LIBBY CONCENTRATE LOADOUT

Concentrate from the mine is hauled by truck to a rail loadout in the town of Libby. The

concentrate load out facility is located in an existing industrial building located on the east

side of Libby, previously used for load out of plywood and currently managed by the Libby

Port Authority. Approximately one third of the building is used for concentrate loading. The

existing building has a concrete floor and a rail siding allowing four to five rail cars to be

loaded inside the building. Rail cars are loaded with a front-end loader. Cars are covered

with either physical or sprayed on covers prior to leaving the load out building. Any

concentrate spillage would be contained within the building area and is periodically cleaned

as necessary from the floor or lined track area.

3.10 CHEMICAL AND FUEL STORAGE

There is no PCB containing equipment underground or on surface. Solvents for cleaning

machine parts are provided by a contract service and managed by complete containment.

Spent solvent is periodically removed from the site by the contractor. Typical fuel and

chemical storage at the Troy Unit is summarized in Table 3-2.

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TABLE 3-2. TROY MINE OPERATIONAL FUEL AND CHEMICAL INVENTORY

Location	Volume	Units	Product
Underground	5000	gallons	diesel
Underground	1000	gallons	motor oil 15/40
Underground	1000	gallons	hydraulic oil ER200
Underground	500	gallons	gear oil 90 wt
Underground	1000	gallons	antifreeze
Fuel station near shop	10000	gallons	diesel
Fuel station near shop	1000	gallons	motor oil 15/40
Fuel station near shop	1000	gallons	hydraulic oil ER200
Fuel station near shop	500	gallons	gear oil 90 wt
Fuel station near shop	1000	gallons	antifreeze
Mill	40000	lbs	potassium xanthate
Mill	1000	gallons	pine oil
Mill	2000	gallons	frother (Dow 250)
Mill	3000	gallons	flocculants
Mill	3000	gallons	coagulant
Laboratory	50	gallons	misc chemicals
Warehouse/shop	50	gallons	paint thinner
Warehouse/shop	10	drums	specialty products
Warehouse/shop	10	drums	used oil
Surface explosives site	60000	gallons	propane - two tanks
Surface explosives site	2000	gallons	diesel - for ANFO
Surface explosives site	500	gallons	dye
Surface explosives site	10000	gallons	ammonium nitrate

4.0 FACILITY REMOVAL AND REGRADING PLAN

**4.1 ROADS** 

Roads associated with the mine are shown on Exhibit A. Existing Special Use Permits for

use of Forest Service roads are listed in Table 1-3. The existing USFS roads will remain in

place per USFS requirements. The final plant site regrading plan will leave roads designed

to USFS specifications as shown on Exhibit F. The current paved surface of the main access

road will remain in place. During the summer of 2005, Genesis Inc. had approximately half

of the mine access road repaired and repaved per the USFS Special Use Road Permit.

4.2 DEVELOPMENT ROCK PILES

Since the development rock piles are part of the current plant site these areas will be

incorporated into the final grading plan for the plant site as described in Section 4.5. Exhibit

F illustrates how these areas will be recontoured and the final placement of the USFS road.

Development rock associated with portal patios will be regraded and reclaimed as described

in Section 4.3.

4.3 MINE OPENINGS

The North and South Adit patios will be regraded by pulling material from the edge of the

patio fill slope and placing this material as a wedge against the cut slope. Exhibit F and

Figure 4-1 show the post mine topography and cross sections of the existing and regraded

portal patios. The plan is to pull material back from the crest of the dumps and to move this

material to the toe of the cut slopes creating an out sloped surface. Regrading will attempt to

place finer grained materials near the surface to promote revegetation. A 12 inch layer of

cover soil from a local borrow source will be placed over the regraded surface (Table 4-1).

The regraded areas will be revegetated with the upper elevation forest mix consisting of tree

and shrub seedlings plus some grass and forb seed. The angle of repose rock slopes below

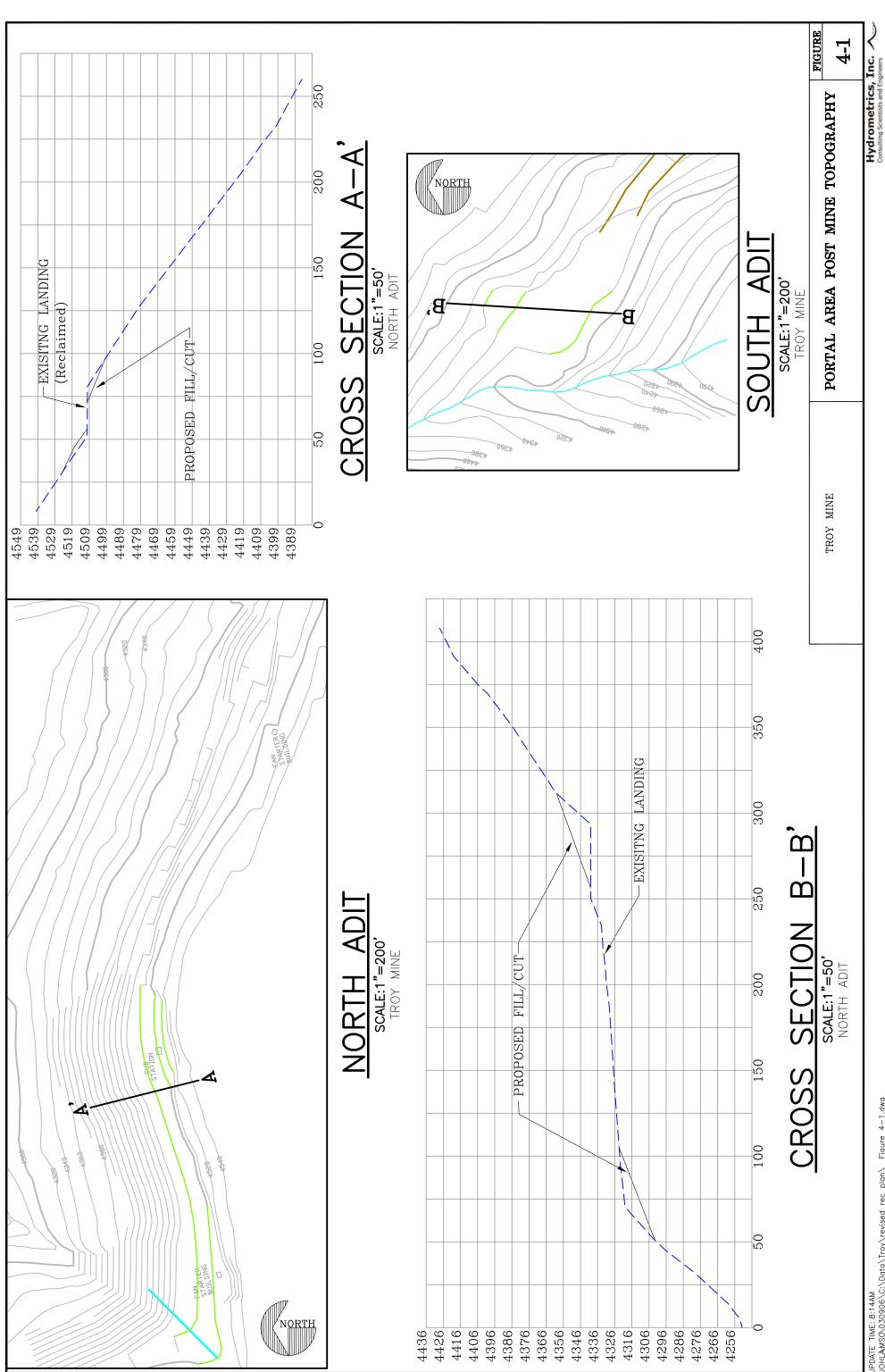
the adit patios will be not be regraded.

The fill material at the adits is primarily development rock consisting predominantly of

cobble and larger sized material. Rock fill material for the portal closures will be obtained

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# TABLE 4-1. ESTIMATED COVERSOIL REQUIREMENTS

Description	Final Disturbed	Area Requiring	Soil Volume	Soil Depth	Current Reclamation	Proposed Soil Source
Tailings Impoundment Area	Alca (acies)	Necramation (acres)	(cent) na unhavi	wedanieu (menes)	Status	
Impoundment berm	42.07	00.00	0		Soil & reveg complete	none
Cell one surface	82.77	80.88	195730	18	none	tailings area borrow
Cell two surface	89.12	87.94	212815	18	temporary revegetation	tailings area borrow
Cell three surface	123.87	121.96	295143	18	none	tailings area borrow
Decant Ponds	7.31	7.31	17690	18	none	tailings area borrow
Toe ponds	4.95	0.00	0	•	natural revegetation	none
Toepond topsoil piles	43.56	0.00	0	•	revegetated	none
East topsoil pile	0.45	0.45	1089	18	temporary revegetation	use existing soil
NE borrow area	1.44	0.00	0	•	revegetated	use existing soil
East borrow pits	10.57	7.84	12649	12	2.73 acres revegetated	use existing topsoil
Cell 3 borrow pits	10.79	10.79	17408	12	not disturbed	use existing topsoil
Tailings Impoundment Roads	10.55	4.55	11011	18	none	tailings area borrow
Reclaim Pump & Pond	0.80	0.80	1671	12	none	tailings area borrow
Maintenance Sump	1.09	1.09	1759	12	none	tailings area borrow
Subtotal	429.34	323.61	285992			
Plant Site						
Office/Shop Pad	11.60	10.39	0	12	none	inplace stockpiled soil
Upper Perc Pond	0.56	0.56	903	12	none	plant site fill/borrow
Lower Perc Pond	1.46	0.00	0	12	revegetated	plant site fill/borrow
Stormwater Pond	1.53	1.53	2468	12	none	plant site fill/borrow
Old Warehouse Pad	3.86	3.86	0	12	none	inplace stockpiled soil
Office/Mill Corridor Reclaimed	3.03	0.00	0	12	resoiled and revegetated	plant site fill/borrow
Mill Area Pad	10.80	9.35	15085	12	none	plant site fill/borrow
Water tank; includes road	1.08	1.08	1742	12	none	plant site fill/borrow
Subtotal	33.92	26.77	20199			
Mine Portals						
North portal (Total Area)	11.71	2.52	4066	12	Fill slopes revegetated	local borrow
South Portal (Total Area)	3.57	1.19	1920	12	none	local borrow
Subtotal	15.28	3.71	5885			
Utility Corridor						
Tailings line footings	0.67	0.67	0	. (	none	none, removal line + reveg
Pumpstation	0.91	0.91	1468	21	none	tailings area borrow
Borrow pit	3.00	3.00	4840	12	none	plant site fill/borrow
Subtotal	4.58	4.58	8089			
Doods						
FS 4626 HV 56 to mine	27.61	00 0		,	none	none remains nost mine
FS 4626C to Perc Ponds	1 29	0000		•	none	none remains post mine
FS 4626F to North Portal	1.14	000			none	none pre-existing remains post mine
FS 4626/4628 Mill to South Portal	25.37	00.0			none	none pre-existing remains post mine
FS 4628C to South Portal	68 0	000		•	none	none, remains post mine
Subtotal*	56.30	0.00	0			
TOTAL ALL AREAS *	539.42	358.67	9L066L			
* Note: total disturbed area includes FS roads that existed prior to mine permit	es FS roads that existed	I prior to mine permit				

from the portal patio crest. Portal closure backfill volumes are summarized in Table 4-2.

Fine-grained material, if available at the adit site or imported borrow, will be used to cover

the rock fill.

The adit portal fill slopes were originally permitted to be left at angle of repose. The North

Adit dump slope and has been revegetated including planting of 3750 tree seedlings in 1997

and 1999. Because of the coarse nature of these slopes precipitation largely infiltrates into

the coarse rock fill even during high flow events.

Ore grade rock was removed from the North Adit dump during the period of temporary

closure and this material has been run through the mill. Some mineralized material will

remain in place in the South Portal dump. This material has shown no impact to the

environment in the last 20 years and is not expected to in the future. Removal of this

material would require considerable disturbance of adjacent areas for access.

Development plans for the south adit will result in reconfiguration of the adit to create a

decline from the portal entrance back into the mine. This change in slope will eliminate the

possibility of water discharging from the south adit during operations. At closure, the portal

will be regraded and revegetated. No discharge from the South Adit is expected during

operations or closure because as the SOB fills with water, the water will flow down to the

service adit before the water level could reach the south adit.

Adit closure plans are that all mine openings will be sealed against entry. This will be

accomplished by backfilling with mine rock or material obtained during the regrading of the

portal areas. Backfill will be placed from the opening back into the adits 30 feet and will be

placed tight to the back (roof).

**4.4 UNDERGROUND FACILITIES** 

Underground facilities such as the jaw crusher, conveyor belt, rollers, and underground

ventilation system will be salvaged if a suitable market is found. If a salvage market can not

be found, this equipment will be abandoned in place. If the crusher or conveyors are not

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	TABLE	4-2. TRC	Y MINE PO	RTAL C	LOSURE RO	TABLE 4-2. TROY MINE PORTAL CLOSURE ROCKFILL QUANTITIES	
Portal	Width	Height	Avg. Length*	Yards	Fill Material /Gradation	Compaction	# Steel Sets to be removed
Service Adit	25	20	40	741	See Note 2	Dozer/loader backdragging	9
Conveyor Adit	16	12	28	199	See Note 2	Dozer/loader backdragging	က
South Adit	19	12	28	236	See Note 2	Dozer/loader backdragging	0
East Adit #1	23	19	39	631	See Note 2	Dozer/loader backdragging	0 (bald)
East Adit #2	21	23	45	805	See Note 2	Dozer/loader backdragging	ဇ
North Adit #1	21	17	36	476	See Note 2	Dozer/loader backdragging	ဇ
North Adit #2	21	17	36	476	See Note 2	Dozer/loader backdragging	2
North Adit #3	20	17	36	453	See Note 2	Dozer/loader backdragging	2
West Adit #1	20	16	34	403	See Note 2	Dozer/loader backdragging	ဇ
West Adit #2	0	0	0	0	reclaimed	Dozer/loader backdragging	0
TOTAL				4,421			

\* Note 1: Based on 30-degree fill ramp, 10' of fill contact length against the back, and 38-degree backslope Note 2: Rip floor, then fill with borrow rock grading to finer material near top

removed for salvage value they would have any oil sumps or reservoirs cleaned. Equipment

removed from underground would be relocated to the industrial site for reuse, resale or

scrapped.

Oil switches, transformers and motors with oil sumps will be removed. Removal of any

electrical service from underground except for oil filled switches and transformers is not

proposed. There are 10 oil switches located at sites shown on Exhibit D. These switches

contain 1.5 gallons of oil each. There are two transformers located underground as shown on

Exhibit D; each transformer contains 262 gallons of oil. Additionally any oils, lubricants,

cleaners or chemicals used underground would be removed at the cessation of mining.

Mine openings will be sealed against entry and the portal area around the openings will be

re-contoured with a subsequent layer of coversoil as described in Section 4.3.

4.5 MECHANICAL VENTILATION SYSTEM

All components of the mechanical ventilation system are underground. The ventilation fans,

motors and attached electrical components will be removed and disposed of off site. Metal,

fiberglass, wood, concrete or other inert components of the ventilation system will remain

underground.

4.6 MILL AND PLANT SITE

Equipment from the mill, shops, office and associated facilities will be removed and salvaged

or disposed of off site. Buildings will be salvaged and removed or demolished. The

materials from the mill, shop and office sites that will be buried on site are primarily

concrete, but also include some metal, glass, plastic and wood that will result from building

demolition. Concrete from buildings and foundations will be buried on site with a minimum

of three feet of cover material.

Asphalt from the paved plant site area will be ripped and buried in place with a minimum of

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three feet of cover material.

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A conceptual grading plan for the mill and office shop sites is presented in Exhibit F. Cross

sections of the plant site post mine topography are shown in Figure 4-2. The volume of

material estimated to be moved as part of the mill site regrading is 27,000 yds<sup>3</sup> and 54,000

yds<sup>3</sup> for the office/shop area.

The outsloped recontoured surface of the mill area is shown on Figure 4-3. There will be

two reconstructed stream channels through the mill area and none through the shop and

office area. Existing culvert locations are shown on Exhibit A and final reclamation culverts

are shown on Exhibit F and Figure 4-4. Design of reconstructed channels is shown in Figure

4-4. Reconstructed channels will be armored with coarse rock of suitable size to protect the

general channel alignment during flows of a 100-year, 24-hour design flow. Energy

dissipation for the reclaimed channels will be provided by the existing coarse rock fill on the

fill slopes prior to re-entering the downstream channels.

Existing water diversion culverts (Exhibit A) will be sealed by plugging the upper end with

concrete. Flow from the natural drainages will be routed across the reclaimed mill site area

through an armored channels. Velocity and erosion control will be supplied by installing a

rock catch basin at the bottom of the slope where the channels discharge to the original

channel.

Growth media stockpiled within the mill and office/shop pads will be used as the source for

cover soil in the mill site area. Since it is not known how much cover soil is available for

salvage, the upper percolation pond embankment and/or old warehouse pad slope located in

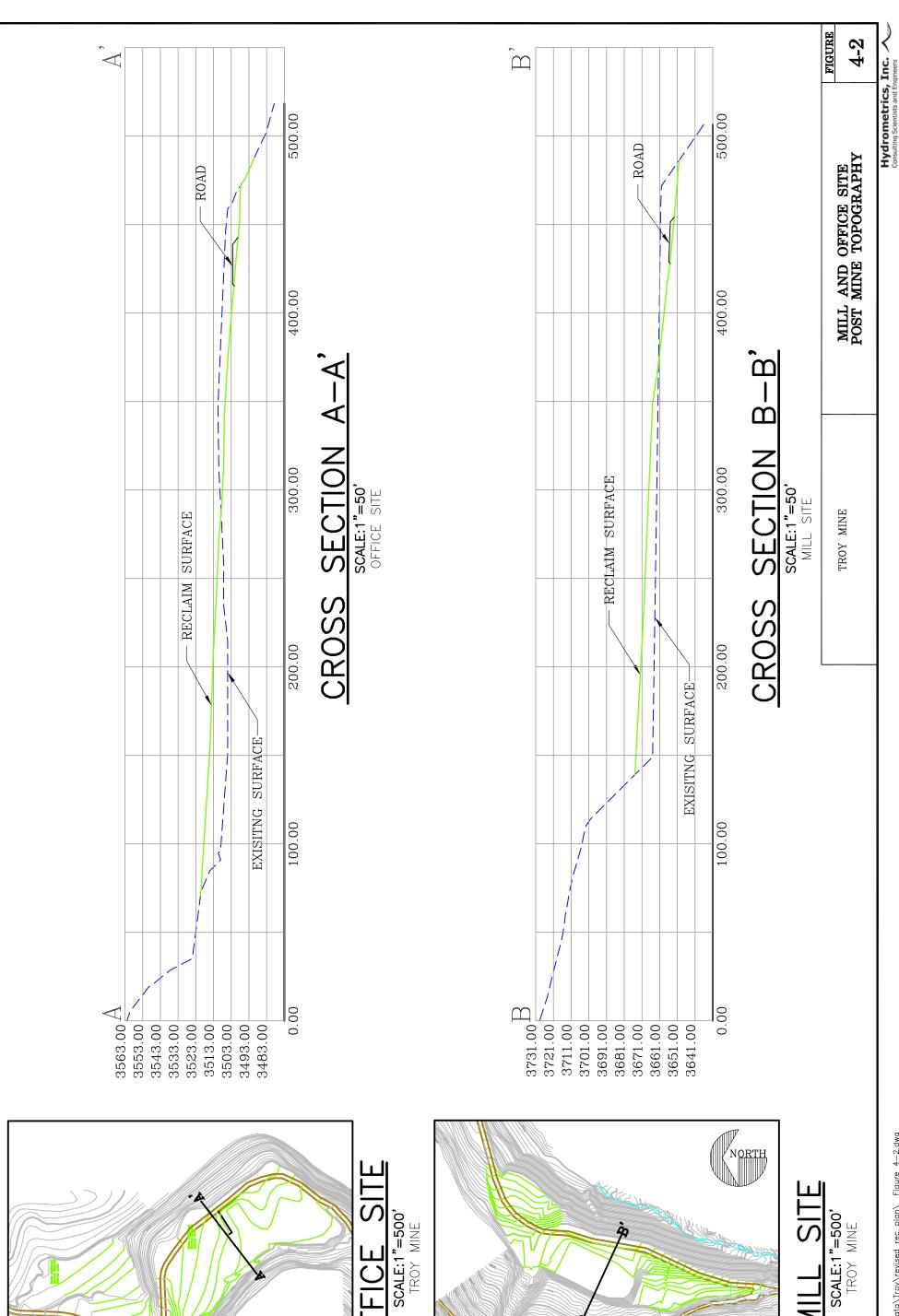
Section 24 to the north of the office building, would be the next choice for material for the

remainder of mill area reclamation. If additional cover material is required, the USFS

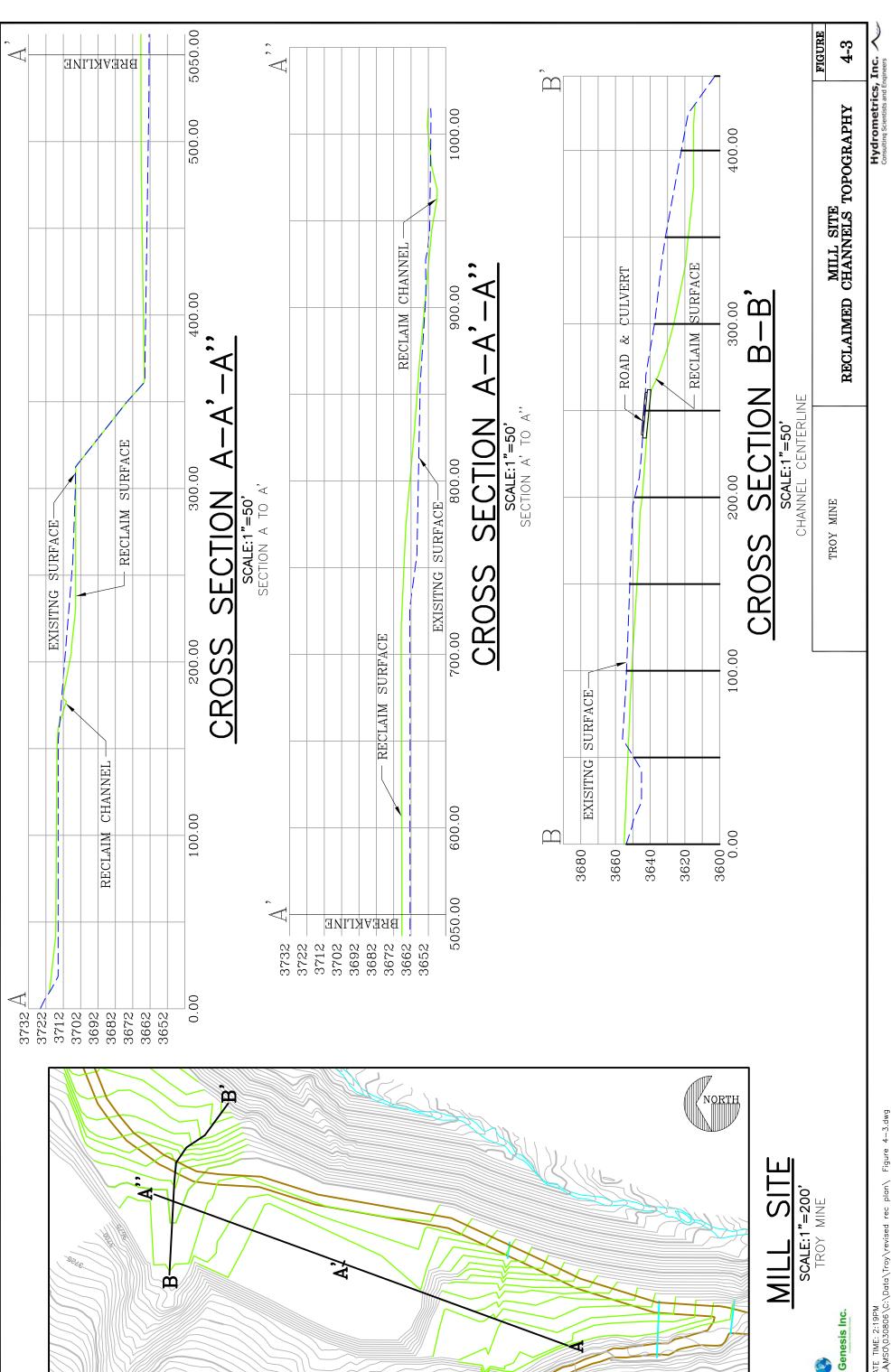
borrow site located along the road in Section 24 to the north of the office could be used.

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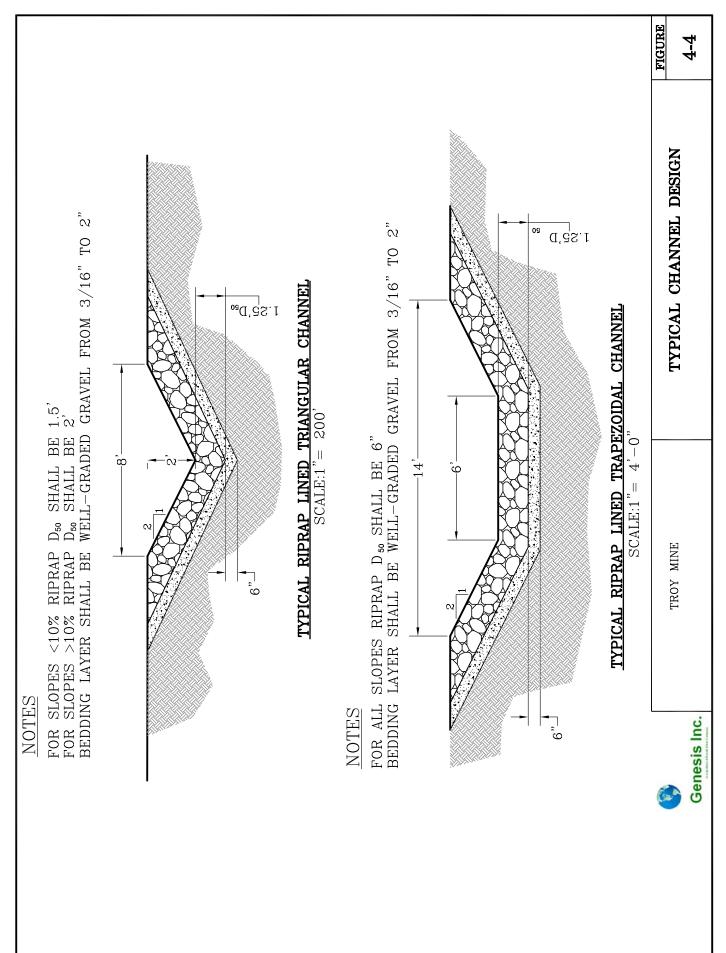
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Suitable soil material from the mill and shop/office pad areas would be utilized prior to

utilizing the upper percolation pond embankment, old warehouse pad slope, or the USFS

borrow site. The upper percolation pond embankment and old warehouse pad slope have

been reviewed and approved by the US Forest Service (Lou Kuenen, 7-14-05). The upper

percolation pond embankment, old warehouse pad slope, and USFS borrow site are shown on

Exhibit A.

It is assumed that original site soils had significant coarse fragment content and if these soils

can be salvaged from the existing fills they will be used. If sufficient coarse fragment

content is not available in the salvaged soil or if sufficient salvaged soil is not available,

borrow soil from the Forest Service borrow pit, which has significant coarse fragment

content, would be used to re-soil steeper slopes. Estimated reclamation coversoil

requirements and source locations are shown in Table 4-1.

The salvaged soils now located within the plant site fills (supplemented as necessary by

borrow soils) will provide a growth media meeting the requirements of the forest

revegetation type proposed for the site in Section 6. Plant, mill, and borrow site coversoil

volume calculations are included in Table 4-1.

**4.7 BORROW SITES** 

The existing hillside USFS borrow site will be reclaimed upon completion of borrow

excavation activities unless the USFS prefers continued use. Post closure topography for the

borrow areas will be regraded to mesh with existing slopes. Following site grading the

borrow site will be planted to the upper elevation forest type using procedures specified in

Section 6. A conceptual grading plan for the borrow area site is presented in Figure 4-5.

Figure 4-5 shows the existing borrow pit and maximum potential area for expansion. The

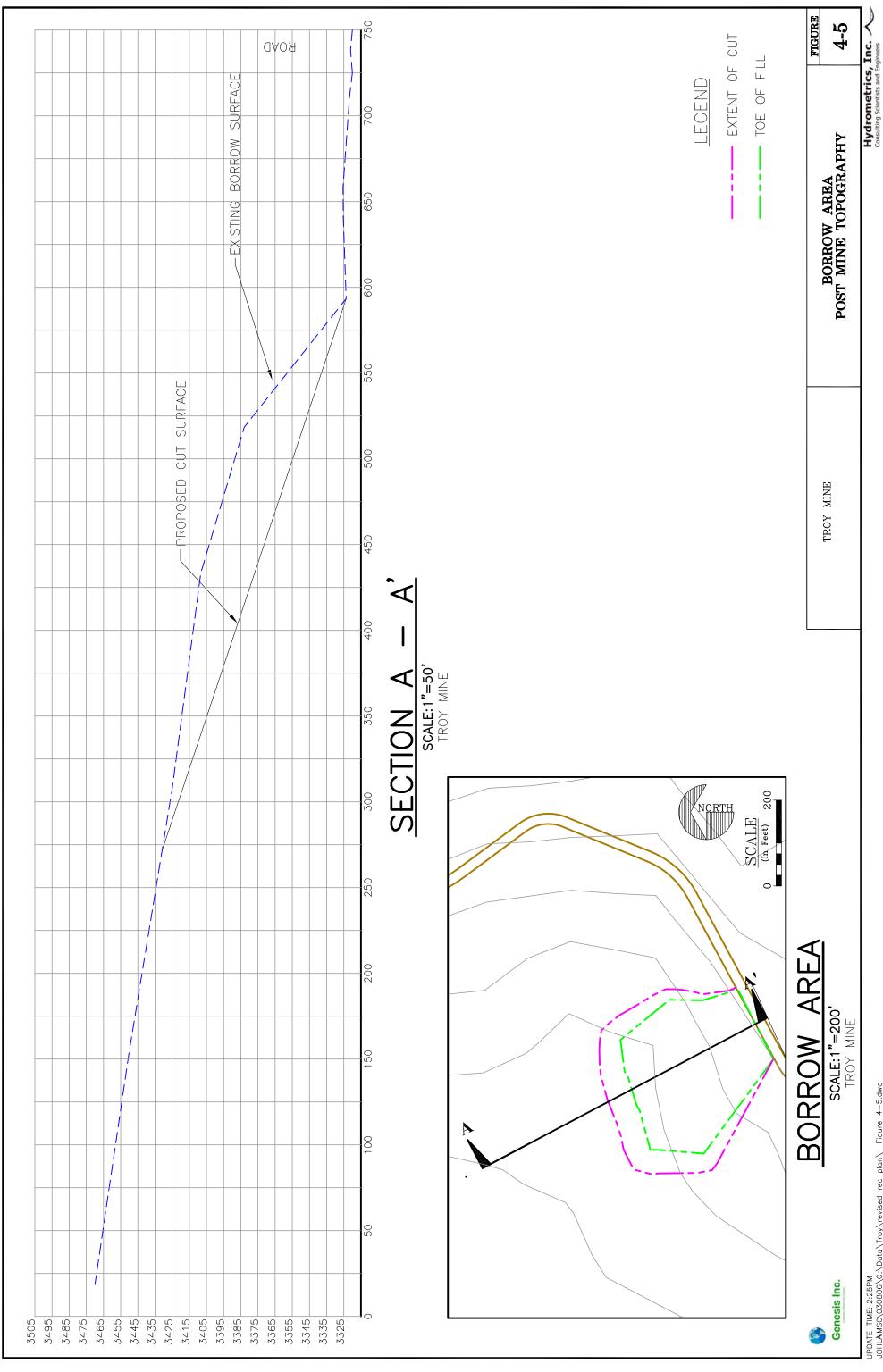
existing borrow pit has a disturbed area footprint of about 2 acres. If expanded to about 4

acres the borrow pit could provide up to 70,000 yds<sup>3</sup> of soil material suitable for site

reclamation. The borrow pit expansion would extend the edge of the pit 100 to 200 feet and

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UPDATE TIME: 2:25PM JOHLAMSO\030806\C:\Data\Troy\revised rec plan\ Figure 4-5.dwg

result in final pit slope of 2:1. Figure 4-5 shows a cross section through the existing and

reclaimed borrow pit. The borrow pit soils have considerable coarse fragment content, but

would be suitable for establishing successful revegetation at the site. Soils with higher

coarse fragment content would be used on steeper slopes.

4.8 STORM-WATER COLLECTION AND DIVERSION

During the building demolition phase, the existing storm-water collection system will remain

in place with additional best management practices such as silt fences and other control

structures placed as required. The final grading plan will incorporate diversion ditches,

culverts and velocity control structures as required to reduce the potential for sedimentation

in Stanley Creek. Areas of expected high run-off will use riprap as required to control

erosion.

4.9 FUEL AND OTHER TANKS

The surface diesel fuel tank (capacity 200,000 gallons) will be sold or drained, cleaned and

cut up for scrap. The two large propane tanks (capacity 30,000 gallons each) as well as

numerous small propane tanks will be transported off the site. All other tanks (underground

storage tanks) were removed from the site in 1996. A listing of existing fuel storage is

contained in Table 3-2.

4.10 POWER SUPPLY

The main power line is the property of Northern Lights Inc. Removal of the substations and

115 kV power line and poles will depend on the ultimate need for power at the site. At this

time it is anticipated that the power line will only be removed from the plant site down to

Highway 56. Northern Lights will use the remaining line to meet power requirements in the

area.

The only powerlines owned by the mine are a section from the decant pond to the Quonset

hut on the east side of the tailing facility and a section above North Adit (see Exhibit A).

Both of these lines are entirely on private ground. The remaining powerlines belong to the

local power supplier, Northern Lights.

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4.11 WATER SUPPLY

Water supply at the plant site consists of a well, piping and the large water tank (capacity

300,000 gallons). At reclamation, the tank will be sold or cut up for scrap metal. The buried

pipelines will be abandoned in place. The domestic water well may be used for irrigation of

the reclaimed area if necessary for the first season then plugged and abandoned as required

by MDNRC rules (ARM 36.21.810 Abandonment). The large capacity make-up water wells

located near the Stanley Creek bridge will also be abandoned and the small pump buildings

and surge pond will be reclaimed.

4.12 SEWAGE TREATMENT FACILITY

The sewage treatment facility will be removed and the building will be salvaged. Once these

facilities are decommissioned, portable toilet facilities will be provided for the reclamation

workforce.

4.13 PIPELINES

All surface pipelines (mainly the two 8-inch steel tailing lines) will eventually be removed

and salvaged. But before the tailing lines are removed, they will be used one-by-one to pipe

mine water to the tailing facility until they wear out or the water quality improves enough to

permit discharge to Stanley Creek. Sections of the tailing line buried less than 3 feet will be

removed. All surface pipeline support structures for these lines will also be removed. All

buried pipelines will be capped as required and abandoned in place.

The above ground portion of the two 8 inch tailing lines will be disassembled at the Victaulic

couplings and the 20 foot pipe sections loaded on trucks and sold, scrapped, or disposed of

off site. The 1 foot x 6 foot concrete pipeline support structures are located approximately

every 20 feet along the above ground pipeline will be lifted by a crane or excavator bucket

and loaded onto trucks for transport and on-site disposal at the tailing facility or mill site.

The support structure footprints (estimated to be 3 feet x 7 feet) will be the only disturbance

requiring reclamation. The pier footprints will be smoothed with the excavator bucket after

removal of the concrete. These areas will be seeded with a broadcast seeder with the

Genesis Inc. P.O.Box 1660 grassland seed mix and will quickly revegetate. A short section of trestle will also be

removed. Most of the concrete tailing line support structures will be buried in the tailing

facility, but some may be buried at the office/warehouse site.

The maintenance sump, located approximately 1,500 feet south of the reclaim water sump,

consists of an unlined, shallow excavation (0.5 acre, 4 to 5 feet deep) in native materials.

This excavation will be graded to blend with surrounding topography and original soil from

the area will be spread and seeded.

4.14 TAILING FACILITY

When milling ceases, the tailing surface will slope to the east at an approximate grade of

about one half of one percent. Surface flows will periodically inundate small areas on the

eastern edge of the impoundment. Water will infiltrate and recharge groundwater. No major

regrading of the impoundment surface is proposed.

**4.14.1 Stability Considerations** 

The long-term stability of the facility is high due to the design features of a fully drained

impoundment. Monitoring wells and phreatic surface monitoring within the impoundment

demonstrate that the facility continues to dewater. (See Appendix I - Tailing Impoundment

Stability Report by George Toland, P.E.) Erosion of the facility by water and wind will be

controlled by the soil/vegetation cover described below.

**4.14.2 Toe Ponds** 

As described in the water management plan (Section 3.8.2), the toe ponds capture

groundwater below the tailing facility. The toe ponds will be retained as permanent features

to provide wildlife and wetlands habitat.

Post operation toe ponds are shown on Exhibit F. Toe ponds will be connected by inter-pond

channels at closure. A conceptual design for an inter-pond channel structure is shown in

Figure 4-6. No outfall from the post closure toe ponds is anticipated and although an

armored outfall will be installed as a safety measure, no channel to Lake Creek is proposed.

**4.14.3 Soil Cover** 

Previous vegetation trials at the site have shown that tree growth is better with borrow soil

than with the previously stockpiled soil. Additionally, leaving the currently revegetated

stockpile along Lake Creek will provide the berm to maintain the toe ponds and minimize

potential for sediment reaching surface water in Lake Creek. Coversoil for the tailing facility

surface will be obtained from the borrow pits located to the east of the impoundment (Exhibit

A). Tailing facility coversoil volume calculations are included in Table 4-1. Approximately

766,600 cubic yards of coversoil materials will be required for tailing facility reclamation.

The planned approach to impoundment coversoil placement will be to complete placement of

18 inches of borrow soil over the 303 acre impoundment surface. These borrow soils will

provide mineral soil comparable to adjacent native forest soils.

An area of approximately 15 acres on the east side of impoundment Section I is currently

undisturbed. As this area of Section I is needed for tailing storage, topsoil will be stripped

and stockpiled for subsequent reclamation of the area.

4.14.4 Topsoil Stockpile Sites

The existing topsoil stockpile site on the west side of the impoundment (44 acres) is

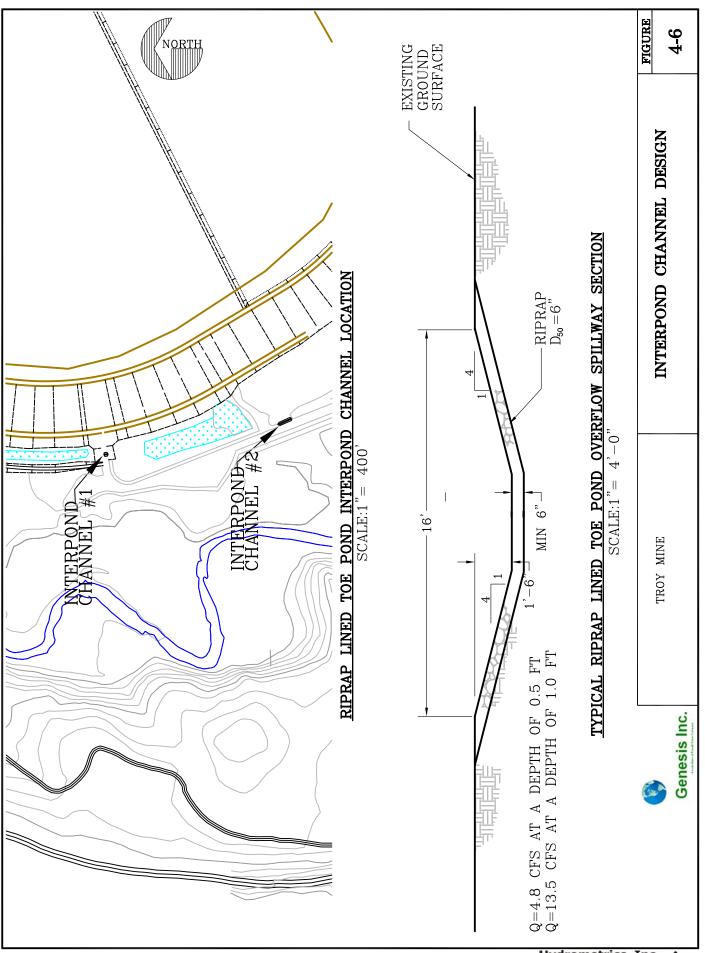
revegetated with a broad range of grass, shrub and tree species. This stockpile will remain in

place and other than ongoing weed management requires no additional reclamation. The soil

stockpile to the east side of the impoundment (about 0.5 acre) will be reclaimed upon

completion of project topsoil spreading activities.

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### 4.14.5 Borrow Sites

Two existing hillside borrow sites, the NE Impoundment Borrow and the East Impoundment Borrow, and a new proposed area (Cell 3 Borrow Pits) will be reclaimed upon completion of impoundment borrow excavation activities. Site grading activities will include slope reduction (to 2:1) and the establishment of upper slope diversion ditches. Following site grading, the borrow sites will be planted to a lower elevation forest type using procedures specified in Section 6.

## 4.14.6 Decant Ponds and Wetland/Open Water Options

When mine water is no longer routed to the tailing facility, the existing three decant ponds will be recontoured to form a shallow depression. The shallow depression will act to capture any runoff from the tailing facility surface and prevent surface water runoff from leaving the impoundment area. In addition, this low area will provide wetland habitat. The existing surface grade from the main perimeter dike of the impoundment is towards the decant ponds. To control runoff from the impoundment, this grade will be maintained after soil cover is applied. This will ensure that all excess mine water and precipitation water on the impoundment will report to the east side of the impoundment at the approximate location of the decant ponds.

### 4.14.7 Irrigation System

The current irrigation system consists of large irrigation sprinklers ("Big Guns") and aluminum sprinkler pipe and utilizes water from the mine during the initial revegetation growing season. Irrigation equipment includes 5,500 feet 10" pipe, 20,000 feet 4" pipe, 74 big gun sprinkler heads, one 75 HP pump and one 100 HP pump. The pipe is aluminum and is in 30 foot lengths. In the first year or two following closure assuming mine water is still available, the pumps will not be needed and gravity pressure will be adequate to run the irrigation system. If the portal plugs are installed and return water line reclaimed prior to final tailing revegetation, groundwater will be used for irrigation. It is anticipated that irrigation would be used for one to two years following final reclamation to help establish a vegetation cover and assure that wind erosion is not a concern.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 Mine water supplies this system with sufficient pressure (head) due to the elevation difference between the mine plant site and the impoundment such that no pumping is needed. Once adequate revegetation results are achieved after the initial growing season, the irrigation system will be salvaged and removed from the area.

### 4.14.8 Reclaim Pump Stations

The reclaim pump stations, located south of the impoundment and next to the Stanley Creek bridge, will be salvaged and the buildings will be removed. The liner of the reclaim water pond will be cut, folded in on itself, buried in-place, and the depression graded to blend with the surrounding topography. The site will be revegetated to grassland relying on natural reinvasion of woody species.

### 4.14.9 Quonset Hut

The Quonset Hut will be utilized for storage and office space after the removal of the plant site facilities. The Quonset Hut building is on private ground and the building and surrounding 13.6 acres will be retained for industrial use (Exhibit E). This area will be utilized for storage and management of reclamation activities after the office and mill site facilities are removed. The 13.6 acres of the industrial site will remain as-is and disturbed areas (road, parking and Quonset Hut) will not be reclaimed.

### 4.15 MONITORING WELLS

Wells listed in Table F-1 are proposed for operational monitoring and will remain into the post closure period until no longer needed. Figure F-1 in Appendix F shows location of monitoring wells in the tailing pond area. Exhibit A also shows these wells plus surface water monitoring sites. Table F-2 in Appendix F provides details on monitoring well completion. Table F-1 in Appendix F lists wells proposed to be maintained into closure. At such time that final closure is approved these wells will be abandoned in accordance with Montana rules (ARM 36.21.810 Abandonment). Existing wells in the tailing facility not included in the monitoring plan will also be plugged and abandoned as required by Montana law. Well 01-15 near the decant pond will be fitted with a riser and protective casing in an attempt to maintain it during the rise of the tailing.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 The geotechnical piezometers were installed for monitoring water levels in the embankment.

These piezometers are utilized in geotechnical monitoring but are not as part of the

hydrologic monitoring program.

# **4.16 FENCES**

All fences will be removed during demolition of the plant site.

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5.0 SOIL RESOURCES

The facility removal and regrading plan (Section 4) and the revegetation plan (Section 6)

describe use of available topsoil and subsoil resources. To evaluate the available soil

resources, investigations of stockpiled topsoil and site borrow soils were conducted in

October 2000. Selected stockpile and borrow sites were sampled for laboratory analysis of

relevant physical and chemical parameters.

5.1 SOIL INVESTIGATIONS

In order to assess the potential of stockpiled topsoil and developed soil borrow sites for use

in Troy Mine reclamation, a total of 18 test pits were excavated and evaluated in the area of

the tailing facility and the plant site. Native soils in these areas were evaluated for

comparison and reference in the design of impoundment and plant site reclamation

coversoils. Tailing facility soil test pit locations are presented in Figure 5-1. Two plant site

soil test pits were excavated at the USFS borrow pit located along the plant access road

approximately one-half mile north of the plant gate.

Field observations recorded at each of the test pits included a description of soil horizons.

Coarse fragment contents were estimated for each horizon. Additional pit site observations

included slope, aspect, and vegetation. A total of 11 excavated test pits were sampled for

laboratory analysis of physical and chemical parameters including texture, saturation

percentage, organic matter content, pH, SAR, available N-P-K, and total metals. All samples

were collected as a composite through the thickness of a given topsoil or subsoil horizon.

**5.2 SOIL ANALYTICAL RESULTS** 

Physical and chemical analyses of topsoil stockpile, borrow site, and undisturbed native soils

evaluated in the area of the tailing facility and the plant site indicate that the quality of the

identified soil sources is acceptable for the design of a suitable reclamation coversoil. A

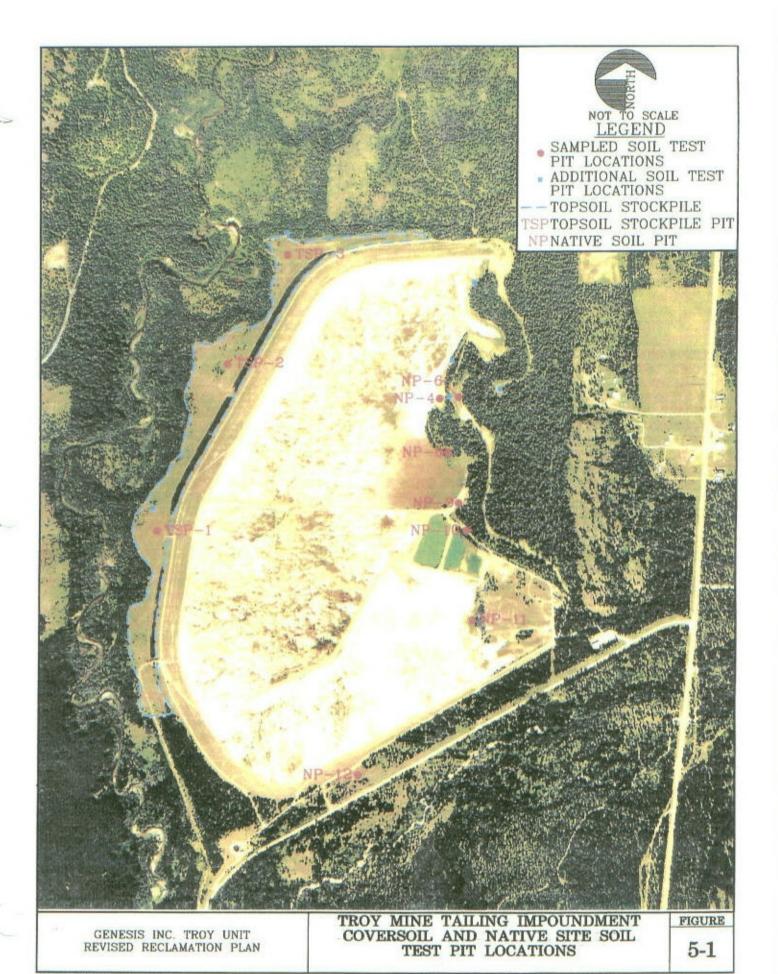
summary of selected parameter results is presented in Table 5-1. Laboratory analytical

reports are presented in Appendix D. Analytical results are supported by visual observations

5-1

and revegetation test plots on the tailing facility.

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Hydrometrics, Inc."

TABLE 5-1. TROY SOILS DATA

			Estimated		
Soil	Soil	Sample	Coarse	Soil	Laboratory
Sampling	Sampling Site Description	Depth	Fragment	Sample Number	Number
Site		Interval	Content (%)		
NP-4	NE Impoundment Borrow Slope	90 – 95 '	75	SMCGI-1000-101	00-59060-1
NP-6	E Impoundment Topsoil Stockpile	0 – 10'	10	SMCGI-1000-102	00-59060-2
NP-8	Native Forest Topsoil	0 – 12"	10	SMCGI-1000-103	00-59060-3
NP-8	Native Forest Topsoil	12 – 48"	75	SMCGI-1000-104	00-59060-4
NP-9	E Impoundment Borrow Slope	80 – 85'	50	SMCGI-1000-105	00-59060-5
NP-10	Native Forest Topsoil	0 – 10"	10	SMCGI-1000-106	00-59060-6
NP-10	Native Forest Topsoil	10 – 60"	50	SMCGI-1000-107	00-59060-7
NP-11	Native Forest Topsoil	0 – 8"	10	SMCGI-1000-108	00-59060-8
NP-11	Native Forest Topsoil	8 – 54"	75	SMCGI-1000-109	00-59060-9
NP-12	Native Forest Topsoil	0 – 10"	10	SMCGI-1000-110	00-59060-10
NP-12	Native Forest Topsoil	10 – 60"	75	SMCGI-1000-111	00-59060-11
NP-13	Plant Site Borrow (USFS)	0 – 36"	50	SMCGI-1000-112	00-59060-12
NP-13	Plant Site Borrow (USFS)	36 – 60"	75	SMCGI-1000-113	00-59060-13
TSP-1	W Impoundment Topsoil Stockpile	0-5'	10	SMCGI-1000-114	00-59060-14
TSP-2	W Impoundment Topsoil Stockpile	0-5'	10	SMCGI-1000-115	00-59060-15
TSP-3	W Impoundment Topsoil Stockpile	0-5'	10	SMCGI-1000-116	00-59060-16

Topsoil Analyses

Laboratory analytical results and field observations indicate that Troy Mine stockpiled

topsoils are of acceptable quality for proposed revegetation efforts. The stockpiled topsoils

(Sampling Sites TSP-1,-2,-3 and NP-6) are primarily a silt loam texture with low coarse

fragment content, moderate water holding capacity, and organic matter contents of 3 to 5

percent. Stockpiled topsoil pH is approximately 6.0 and SAR is less than 0.5. Analytical

data indicate these soils are deficient in nitrogen and potassium and that total metals levels

are acceptable. Comparison of the stockpiled topsoil data with native topsoil data (Sampling

Sites NP-8, -10, -11, -12) show little difference between them.

Subsoil Analyses

Laboratory analytical results and field observations indicate that Troy Mine borrow site soils

are of acceptable quality for use as coversoil in proposed revegetation efforts. The borrow

site soils (Sampling Sites NP-4, -9, -13) are a sandy loam texture with high coarse fragment

content, low water holding capacity, and low organic matter content typical of subsoils in the

area. Borrow site soil pH ranges from 5.6 to 8.4 and SAR is less than 0.4. Analytical data

indicate these soils are deficient in nitrogen, phosphorous and potassium and that total metals

levels are acceptable. Comparison of the borrow site soil data with native subsoil data

(Sampling Sites NP-8, 10, 11, 12) show little difference between them.

Borrow soils and stockpiled soils used for reclamation will be fertilized as necessary to

promote successful revegetation. No addition of organic matter is planned during

reclamation. Reclamation soil requirements and proposed sources are shown in Table 4-1.

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6.0 REVEGETATION PLAN

Revegetation activities have been, and will continue to be, undertaken to:

1. Stabilize disturbed areas through erosion and sedimentation control;

2. Re-establish a vegetative cover that has comparable stability and utility as pre-mine

vegetation communities; and

3. Restore watershed, wildlife, recreational and aesthetic values to meet post-operation

land use objectives.

This plan addresses seed mixes and rates, seedbed preparation, seeding and planting

methods, fertilization, mulching, irrigation and noxious weed management.

6.1 SEED MIXES

Selection of plant species for revegetation is based on pre-mine species occurrence,

establishment potential, growth characteristics, soil stabilization qualities, commercial

availability, experience gained from on-site reclamation activities, and post-mine land use

objectives. Redistributed soil and substrate properties (texture, coarse fragment content,

water holding capacity, permeability and erosion hazard) have also been considered. The use

of native plants has been emphasized.

Seed mixes (species and/or rates) may be modified for the following reasons:

• New releases of species or cultivars;

• Increased or decreased availability;

• Poor seed quality;

• Poor initial performance;

• Deleterious competition with trees and shrubs; and

• Advances in revegetation technology.

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Modifications will be made only after concurrence of MDEQ and the KNF (as appropriate).

Revised mixes would be submitted to the agencies at least two weeks prior to ordering the

plant materials.

Plant materials dealers providing commercial seed will be encouraged to supply seed of local

origin. Local origin is defined as species adapted to the Northern Rocky Mountains and

capable of germinating, growing and producing viable seed at the latitude and altitudes of the

Troy Mine. Only noxious weed-free seed will be used as verified by seed testing analyses.

Broadcast seeding rates range from about 80 pure live seeds (PLS) per square foot (ft<sup>2</sup>) to

about 110 PLS/ft<sup>2</sup>, reflecting higher seeding rates for grassland and lower seeding rates for

forest re-establishment. Lower seeding rates in areas revegetated to forest will reduce

competition between herbaceous and woody species while protecting sites from water and

wind erosion and providing understory diversity. Drill seeding rates will be roughly half the

broadcast rate. Annual ryegrass will be added to the mixes to provide rapid initial

stabilization.

Broadcast seeding rates proposed for wetland types are about 110 PLS/ft<sup>2</sup> for herbaceous

wetland and about 90 PLS/ft<sup>2</sup> for forested wetland.

Table 6-1 and 6-2 list the seed mixes for upland and wetland revegetation respectively.

Three upland mixes reflecting differing post-mine revegetation communities and elevational

differences will be used. The upper elevation forest mix will be used for the plant site and

other upper elevation mine disturbances. The low elevation forest mix will be used over the

majority of the tailing facility surface. It will also be used on the borrow areas east of the

impoundment. The grassland mix will be seeded on a portion of the tailing facility to

establish a mosaic of vegetation types. It will also be used to reclaim smaller disturbances

peripheral to the tailing facility (roads, powerline corridors, equipment storage area, and

other small or narrow disturbances) where natural reinvasion of trees can be expected.

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# TABLE 6-1. TROY MINE UPLAND REVEGETATION MIXES

	SPECIES		SEEDING	SEEDING RATES BY REVEGETATION TYPE	EVEGETATION	ON TYPE	
		Gra	Grassland	Low Elevation Forest	ion Forest	Upper Eleva	Upper Elevation Forest
Common Name	Scientific Name Cultivar	ar PLS/Acre	PLS/sq. ft.	PLS/Acre	PLS/sq. ft.	PLS/Acre	PLS/sq. ft.
GRASSES:							
Fringed brome <sup>2</sup>	Bromus ciliatus	5.00	5	3.00	3	3.00	3
Streambank wheatgrass	Elymus lanceolatus Sodar	3.00	11		ı	2.00	5
Slender wheatgrass	Elymus trachycaulus Primar	r 2.00	8	-	-	1.00	4
Idaho fescue	Festuca idahoensis	1.00	15	1.00	15	1.00	15
Annual ryegrass	Lolium multiflorum	2.00	10	1.50	8	2.00	10
Big bluegrass	Poa ampla Sherman		10	-	-	-	-
Bluebunch wheatgrass	Pseudoroegneria spicata Goldar		10	5.00	16	-	
Columbia needlegrass	Stipa columbiana	1.50	5	5.00	17	3.50	11
FORBS <sup>3</sup> :							
Common yarrow	Achillea millefolium	0.15	6	0.10	9	0.10	9
Fireweed	Epilobium angustifolium	0.10	20	0.05	10	0.10	20
Sticky geranium	Geranium viscosissimum	2.00	2	0.50	1	0.50	1
Blue flax	Linum lewisii Appar	0.50	4	0.40	3	0.40	3
	TOTAL HERBACEOUS	Sn	109		62		78
SHRUBS:		sten	stems/acre	stems/acre	/acre	stems/acre	/acre
Sitka alder	Alnus sinuata			•		2	25
Kinnickinnick	Arctostaphylos uva-ursi			20		1	
Oceanspray	Holodiscus discolor			10	(	•	
Ninebark	Physocarpus malvaceus		-	10	(	25	5
Common snowberry	Symphoricarpos albus		-	30	)	25	5
Serviceberry	Amelanchier alnifolia		-	30	(	25	2
	TOTAL SHRUBS	BS		100	0	100	0
TREES:							
Western larch	Larix occidentalis		-	50	)	5	50
Lodgepole pine	Pinus contorta		-	50	)	1(	100
Western white pine	Pinus monticola		-	75	2	25	5
Ponderosa pine	Pinus ponderosa		-	75	2	25	5
Black cottonwood	Populus trichocarpa		-	25	2	25	5
Douglas-fir	Pseudotsuga menziesii		-	10	0	<i>L</i>	5
Western redcedar	Thuja plicata		-	25	2		
	TOTAL TREES	ES		40	0	300	0

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Based on a broadcast rate of approximately 80 to 110 pure live seeds (PLS) per square foot; rates would be halved for drill seeding.

2 If commercially unavailable, mountain brome (*Bromus marginatus*) will be substituted for fringed brome at a similar rate.

3 The forb component of the revegetation mixtures totals approximately 20 – 35 PLS/sq. ft. (at the broadcast rate). The species for which rates are given are generally commercially available, however, rates may be adjusted to reflect availability and other factors (such as potential use of herbicides at a given site).

TABLE 6-2. TROY MINE WETLAND REVEGETATION MIXES

	SPECIES	SEEDING	G RATES BY R	EVEGETATIO	ON TYPE <sup>1</sup>
		Herbaceou	us Wetland	Forested	Wetland
Common Name	Scientific Name	PLS/Acre	PLS/sq.ft.	PLS/Acre	PLS/sq.ft
GRASSES AND GRASS-	LIKE PLANTS <sup>2</sup> :				
Redtop	Agrostis stolonifera	0.25	28	0.25	28
Fringed brome	Bromus ciliatus	7.00	7	3.00	3
Bluejoint reedgrass	Calamagrostis canadensis	0.50	26	0.40	21
Lentil-fruit sedge	Carex lenticularis	0.75	9	-	-
Tufted hairgrass	Deschampsia cespitosa	0.25	14	0.20	11
Blue wildrye	Elymus glaucus	-	-	4.00	10
Slender wheatgrass	Elymus trachycaulus	2.00	7	1.00	4
Tall mannagrass <sup>3</sup>	Glyceria elata	1.00	4	-	-
Slender rush	Juncus tenuis	0.01	12	0.01	12
Panicled bulrush	Scirpus microcarpus	1.00	4	-	-
_	TOTAL	12.76	111	8.86	89
SHRUBS:		stem	s/acre	stems	s/acre
Rocky Mountain maple	Acer glabrum		-	10	00
Sitka alder	Alnus sinuata		-	10	00
Red-osier dogwood	Cornus stolonifera		-	10	00
Western spirea	Spiraea douglasii		-	10	00
	TOTAL			40	00
TREES:					
Paper birch	Betula papyrifera		-	5	0
Black cottonwood	Populus trichocarpa-		-	12	25
Douglas-fir	Pseudotsuga menziesii		-	12	25
Western redcedar	Thuja plicata		-	10	00
	TOTAL			40	00

 $<sup>1\</sup> Based\ on\ a\ broadcast\ rate\ of\ approximately\ 90\ to\ 110\ \ pure\ live\ seed\ (PLS)\ per\ sq.\ ft.; if\ drill\ seeding\ is\ used,\ rates\ will\ be\ halved.$ 

6-4

<sup>2</sup> Certain species may not be commercially available at the time of seeding. Appropriate substitutions may be utilized (per agency approval) or seed rates may be adjusted to maintain the recommended seeding rate of approximately 90 – 100 PLS/sq.ft.

<sup>3</sup> If Glyceria elata is not commercially available, Glyceria grandis or Glyceria striata will be substituted at equivalent rates (based on PLS/sq.ft.).

Revegetation types for the tailing facility are depicted on Figure 6-1.

Two wetland seed mixes (Table 6-2) will be used. The herbaceous wetland mix will be

seeded in the wetter portions of the wetlands site in Section II of the tailing facility. It will

also be used in those areas where the toe ponds are modified to break up the linear aspect of

the existing toe ponds. The forested wetland mix will be used in the less wet portion of the

wetlands mitigation site in Section II of the tailing facility.

**6.2 SEED APPLICATION METHODS** 

Seedbed preparation will be completed as soon as practical after final reshaping and soil

placement. On gentle slopes (3H:1V or less), the seedbed will be prepared along the contour,

utilizing a chisel-plow, disc, harrow or other appropriate equipment to break up any large

clods of soil. The soil surface will be dozer-tracked or left in a roughened condition on

slopes exceeding 3H:1V, on sites too narrow to operate equipment, or on sites where organic

debris has been respread. The resultant irregular seedbed will reduce soil movement on

steeper slopes and provide microsites for plant germination.

Seeding will be coordinated with other reclamation activities to occur as soon after seedbed

preparation as possible. Seeding will normally be conducted in fall (after September 15) or

spring (prior to May 1) depending on weather conditions. Seeding of upper elevation sites

will be based on access. All spring seeding will be conducted as early in the season as

possible to maximize availability of early moisture.

Two methods of seeding (drill and broadcast) will be employed. Drill seeding may be

utilized on slopes less than 3H:1V. This technique results in proper depth placement of seed

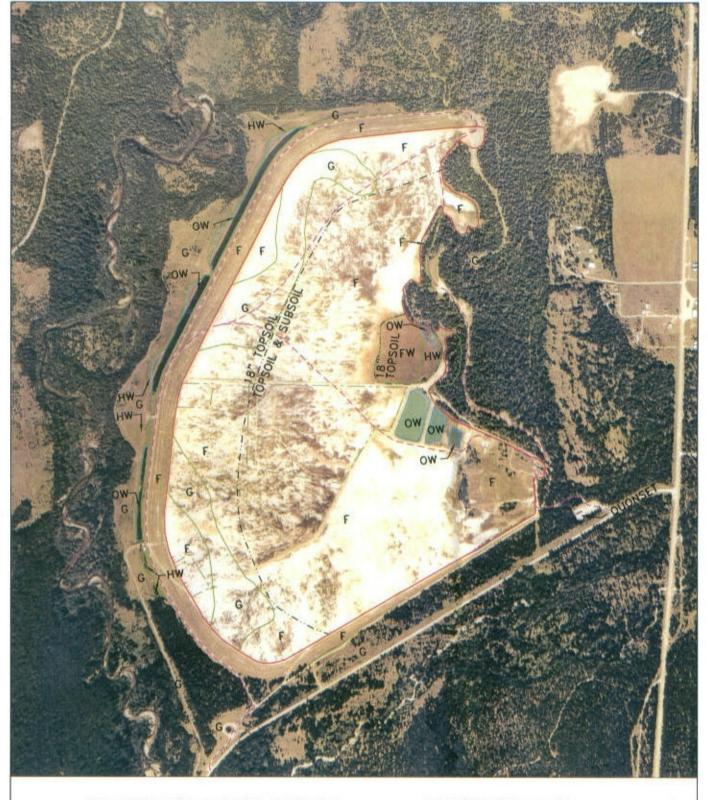
and promotes good contact between seed and soil. Drill seeding will be done along the

contour wherever the surface is not level. Drill row spacing will range from 7 to 14 inches.

Broadcast seeding will be conducted on rocky areas, on slopes steeper than 3H:1V, on areas

where organic debris has been respread and on small disturbances. Seed will be broadcast

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TAILINGS IMPOUNDMENT SURFACE SOIL REDISTRIBUTION DIVISION LINE OPEN WATER (OW)
POST-OPERATION TRAIL RECLAMATION TRIAL SITE

REVEGETATION TYPE: F = LOW ELEVATION FOREST

G = GRASSLAND

HW = HERBACEOUS WETLAND FW = FORESTED WETLAND



WESTECH

Environmental Services, DRAWN BY: DC P.O. Box 6045 Helena, Montana 59604 FILE:TROYO0A01.DWG

SCALE1"=1000' DATE: DECEMBER 2000 CHECKED BY:

TROY MINE TAILING IMPOUNDMENT POST-OPERATION REVEGETATION TYPES

D:\BLOCKS\LOGOS\genesis.tif

FIGURE 6-1

using manually operated cyclone-type bucket spreaders, a mechanical seed blower or

hydroseeder. Seed will be mixed frequently to discourage settling. Where possible and

practical, broadcast seeded areas will be chained or harrowed to cover the seed. Where slope

conditions allow, broadcast seeded areas will be dozer-tracked perpendicular to the slope.

On small or inaccessible sites, hand raking may be used to cover seed.

When hydroseeding is used, seed, fertilizer and mulch (about 250 pounds per acre) will be

sprayed in one application. A second application would be required to spray the remainder

of the cellulose fiber mulch (to achieve a total of about one ton per acre) and a tackifier (at

the manufacturer's recommended application rates).

It is anticipated that most seeding will be by broadcast methods since the plant site and

upper-elevation mine disturbances are too steep, rocky or small for effective drill seeding and

the rough grading on the tailing facility surface would render drill seeding difficult.

**6.3 TREE AND SHRUB PLANTING** 

Trees and shrubs will be re-established on areas designated for a forested revegetation type.

Figure 6-1 depicts post-operation revegetation types for the tailing facility. Methods to re-

establish woody species will include planting, transplanting and natural reinvasion.

Most shrubs and trees will be established by planting, utilizing species that occur within the

mine vicinity. Planting rates are listed in Tables 6-1 and 6-2. Trees and shrubs will be

planted by hand or power-auger. The planting pattern will be random to avoid the

appearance of "plantation-style" row plantings. Generally, early spring plantings are more

successful in this region. If fall plantings are necessary, planting will be delayed until soils

are moist to a depth of one foot.

Planting will be supplemented by transplanting larger trees and shrubs from areas that would

be disturbed by reclamation activities. A tree-spade or front-end loader will be used to

obtain adequate root mass. Survival of trees and shrubs transplanted to the tailing facility

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during revegetation trials has been high. Expected density of transplants would range from 0

to 10 plants/acre depending on availability of material in adjacent areas.

Natural reinvasion of trees and shrubs has occurred at the plant site, tailing line corridor, road

cuts and fills and the periphery of the tailing facility. It is anticipated that woody plant

reinvasion will increase woody plant density above that achieved by planting and

transplanting.

**6.4 FERTILIZATION** 

Inorganic fertilizer will be applied to all reclaimed areas except those within 200 feet of a

perennial stream. Analyses of stockpiled soils are presented in Table 5-1. Based on these

analyses, stockpiled soil nutrient deficiencies can be corrected by the addition of nitrogen (55)

pounds per acre), potassium (40 pounds per acre), and sulfur (10 pounds per acre). Borrow

soils and soil recovered from the plant site fill areas will be tested to determine appropriate

fertilization rates.

Fertilizer will be surface applied using a drop spreader or broadcast spreader or will be

applied as a liquid during irrigation in the first growing season.

6.5 MULCHING

Noxious weed-free straw mulch will be applied to slopes steeper than 20 percent that contain

less than 50 percent coarse fragments at the surface. Flatter slopes may be mulched at

Genesis Inc.'s discretion. On sites where crimping is feasible, mulch will be crimped into

the soil surface using a mulch crimper or by dozer tracking. Straw mulch will be applied at

3000 pounds/acre. To compensate for C:N ratio disruption caused by the addition of straw,

additional nitrogen fertilizer (15 pounds per acre) has been included in planned fertilizer

rates presented in Section 6.4.

Where hydroseeding is used, cellulose fiber mulch will be applied at a rate of about one

ton/acre. A tackifier will be applied at the manufacturer's recommended rate.

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6.6 IRRIGATION

The surface of the tailing facility may be irrigated during the first growing season after

seeding and planting to ensure initial stand development. The sprinkler system currently in

place on the tailing facility would be used for irrigation. The use of irrigation is not planned

at upper elevation sites or where slopes exceed 10 percent. If necessary, however, the plant

site domestic water well will be available for irrigation the first season before it is plugged

and abandoned.

6.7 NOXIOUS WEED MANAGEMENT

Several noxious and non-noxious weeds are present on and adjacent to the mine

disturbances, including spotted knapweed, meadow knapweed, Canada thistle, St. Johnswort,

chrysanthemum, hawkweeds and common tansy. Methods to manage noxious weeds will

include:

• Monitoring of revegetated areas to determine noxious weed presence and density.

• Establishment of forested revegetation communities over the majority of the

disturbed area to shade out weeds as overstory canopy develops.

• Use of a cover crop to provide rapid initial stabilization and competition with weeds.

• Herbicide spraying of topsoil stockpiles and subsoil borrow areas for 1 to 5 years

prior to redistribution to reduce noxious weed seed in the stockpiles and borrow

areas.

• Selective herbicide spraying in areas reclaimed to herbaceous vegetation.

• Weed control along permanent access roads during the life of the operation.

The use of herbicides in areas planted with woody species will be minimized to lessen loss of

woody plants. A weed control plan is provided in Appendix E.

Weed management will be coordinated with the KNF on lands under their jurisdiction. On

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private lands, weed management will be coordinated with Lincoln County.

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7.0 WATER MANAGEMENT PLAN

Attached, as Appendix C is a report evaluating attenuation of metals at the tailing facility

discharge site.

The decant pond can effectively attenuate copper, as under the current disposal system, for

the long term (Land and Water 2004; see Appendix C).

Management of water consists of effective control, conveyance, treatment (if needed), and

disposal of water from the reclaimed mine facilities. Sources of water that require

management during final closure of the Troy Mine are:

• Mine water, or water from the underground workings;

Surface water runoff from the tailing facility; and

Groundwater captured by a sump (enviro-pump).

The goals for the water management plan are to reduce long-term management requirements

as much as possible, to protect water resources, and to integrate water management facilities

and functions with other reclamation components. To the extent practicable, the water

management plan utilizes components that minimize the amount of infrastructure and

manpower that is needed after reclamation (e.g. minimize requirements for pipelines, power

lines, and buildings). Successful reclamation will minimize the length of time that there is

need for active storm-water runoff management. Active management of tailing facility water

will continue until the natural attenuation of nitrogen compounds maintains an acceptable

background quality.

7.1 MINE DRAINAGE QUANTITY

Water inflows to the underground workings consist primarily of rainfall and snowmelt runoff

that infiltrates into the area above the mine and percolates to the underground workings.

Monitoring of mine water flows has resulted in a consistent picture of seasonal mine inflows.

7-1

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Details of mine flooding rates when pumping was suspended in 2003 are contained in

Appendix A. A map detailing the underground workings is included as Exhibit D.

Accurate prediction of mine-water outflow rates and volumes is necessary for proper design

and sizing of mine-water management systems. In August 2000, Genesis Inc. began

monitoring mine-water flows from the service adit and in various areas of the mine in

accordance with the 2000/2001 Mine Water Monitoring Plan for the Troy Mine

(Hydrometrics, 2000a). When mine pumps were turned off in September 2002 a plan to

monitor mine flooding was submitted to MDEQ. Results of this monitoring program are

included in Appendix A. Flow estimates given in this Reclamation Plan are based in part on

the results of the mine water monitoring plan collected to date and in part on best estimates

of mine personnel.

The quantity of water draining from the mine is seasonally variable and depends on the time

of year and the amount of precipitation and snowmelt. Highest inflows to the mine occur

following the spring snowmelt period from approximately April through July, with peak

inflows occurring in mid-June. The timing of the occurrence of peak inflows is remarkably

consistent from year to year, occurring on June 15 or 16 in 4 out of the 5 years (1996 –2000).

Outflows from the mine consist of groundwater flows to the surrounding groundwater

system, pumping from the mine during operations and gravity flows from the service adits.

During operations, outflows from the mine are controlled by pumping rates and gravity flow

from the service adit. Pumping rates from the mine for the period October 1999 to October

2000 varied from 1,000 to 1,200 gpm with the exception of brief periods of shutdown for

maintenance. Pumping at these rates maintained a relatively steady water level in the mine

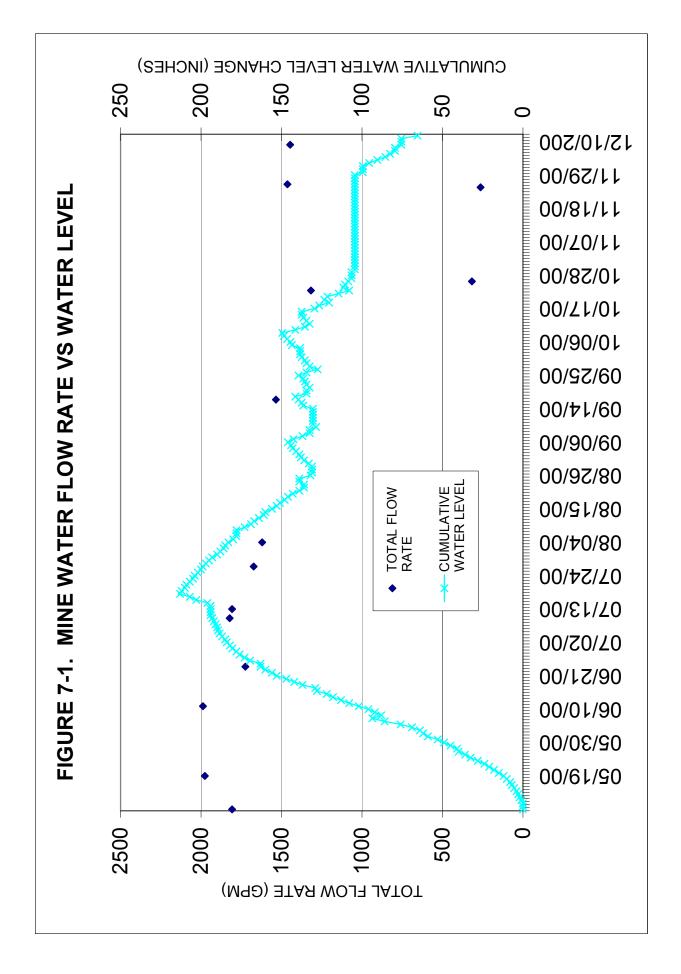
(see Figure 7-1; less than 20 feet of variance in water level occurred during spring through

fall of 2000). Mine inflow rate is estimated to have ranged from 400 gpm to 2900 gpm

during 2003 (Table A-1; Appendix A). Service adit flow rates are estimated to range from

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200 to 800 gpm and average 500 gpm. Total annual average mine-water flow (sum of annual average pumping rate and service adit flow) is estimated to be about 1,600 gpm.

### 7.2 MINE DRAINAGE QUALITY

Water quality data on mine-water outflows is summarized in Table 7-1. Additional mine-water quality data is being collected as part of the ongoing monitoring plan.

# 7.2.1 Portal Plugs

Adit plugs are proposed to be constructed following closure to funnel mine water into a pipeline that will flow through the existing tailing pipelines and discharge into the tailing facility. The three tailing and reclaim pipelines will be used one-by-one to pipe mine water to the tailing facility until they wear out one-by-one or the water quality is suitable for release into the Stanley Creek basin. Following cessation of pumping, water levels will rise in the mine as they did in 2003 when pumping was suspended. As water levels increase it is expected that the mine pool will contact more fractures and increase the rate of recharge to the regional groundwater system through the mine floor. Evidence from mine operations indicates that the SOB and EOB have greater potential to dissipate water than the NOB.

The adit plugs will not be designed to hold back a hydraulic head, but rather to funnel the mine water into the pipeline. Water will not be reservoired behind the adit plugs. In the event that repairs are needed for the pipeline, water can be diverted to one of the other two pipelines. Adit plugs would be located behind the portal rock-fill closures at adit locations that provide high stability and optimize the ability to form a good water seal. Appendix J provides results of an evaluation of general suitability of the Troy Mine for use of adit plugs. Adit plug locations and final design are identified based on site specific investigations as outlined in Appendix J. There would be two adit plugs; one in each of the service and conveyor adits. Conceptual design of adit closure is shown in cross section in Figure 4-2. The rock-fill portal closure is intended to address environmental aesthetics, trespass, and safety issues, protect the pipeline from ground fall, and support the back at the portal to prevent collapse. Rock-fill will consist of development rock salvaged from the portal patios.

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TABLE 7-1. COMPARISON OF AVERAGE MINE WATER QUALITY WITH WATER QUALITY STANDARDS

Parameter	Average * (mg/L)	Water Quality Standard ** (mg/L)	Required Reporting Value
Ag	< 0.003	0.0041	0.003
Al	*** < 0.05	*** 0.087	0.100
Alk.	49	none	none
As	0.005	0.018	0.003
Ba	0.04	2.00	0.005
Be	< 0.001	0.004	0.001
Ca	20.4	none	none
Cd	< 0.0002	0.0014	0.0001
Cl-	1	none	none
CO3	<1	none	none
Cond.	155.7	none	none
Cr	< 0.001	0.011	0.001
Cu	0.112	0.0052	0.001
Temp. F	42.4	none	none
F-	0.056	4	0.1
Fe	0.21	narrative (0.3)	0.01
Hardness	70.4	none	none
HCO3	48.4	none	none
Hg	< 0.0005	0.00005	0.0006
K	<2.0	none	none
Mg	4.7	none	none
Mn	0.13	(0.05)	0.005
NH3/N	0.109	2.139	0.05
Ni	< 0.01	0.029	0.02
NO2/NO3	0.69	10.0	0.01
P	< 0.01	none	0.001
Pb	0.0058	0.0032	0.003
PH	7.66	6.5 to 8.5	none
Sb	0.012	0.006	0.003
Se	< 0.001	0.005	0.001
SO4	23.7	none	none
TDS	108	none	none
Tl	< 0.001	0.0017	0.003
TSS	3.84	none	none
Turb.	2.885	none	none
Zn	0.013	0.067	0.01

<sup>\*</sup> Average concentration of 18 adit water samples collected in 1998 and 1999. For calculation purposes, a concentration of zero was assumed for non-detect values if greater than 80 percent of results were non-detects. Parameters with average concentrations of less than a value (e.g. <0.003) either were not detected in any of the 18 samples or had calculated average concentrations less than the detection limit. Value shown for these parameters is the analytical detection limit. Values for metals are for total metals.

<sup>\*\*</sup> Lowest applicable standard from Montana Numeric Water Quality Standards from Circular WQB-7 (November, 1998). Standards for hardness dependent parameters based on hardness of 50 mg/L. Ammonia standard based on pH of 7.75 and temperature of 5° C.

Iron and manganese have a narrative standards but no numeric standards; values shown in parentheses are the Secondary Maximum Contaminant Limits.

<sup>\*\*\*</sup> Aluminum standard is for dissolved aluminum. Average mine water concentration is for total aluminum.

A cover of local borrow material will allow revegetation and also provide fine grained

material with copper attenuation capacity in the event of any leakage around the adit plugs

and out of the portal.

All adits would be closed. The North Adit is the highest elevation and would be the last to

be closed. The North Adit would provide ventilation and access while working on the other

adit closures. No long-term access to the underground workings is planned. Two concrete

plugs are proposed for the Service & Conveyor Adits at elevation 3720', as shown on Exhibit

D. As ground water fills the mine, it will flow between the various portions of the mine via

internal spillways between the workings as illustrated in the long-section of Exhibit D.

Although the static groundwater levels will fluctuate seasonally, as experienced during

previous shutdown of the mine, the water level in the mine is expected to reach equilibrium

at approximately the 4248 elevation in the SOB and at the 4225 elevation in the NOB and

EOB as shown on Exhibit D. The NOB mine pool will flows to the EOB when it reaches the

4186 elevation. Some groundwater will dissipate into fracture zones as occurred in pre-

mining conditions. Since the mine water flows into the Service Adit at the 4225' elevation,

groundwater can not reach the South Adit portal which is at 4310' elevation. The South Adit

portal will be back-sloped with rock-fill, soiled, and revegetated, but an adit plug will not be

needed. The North Adit portals (4490' elevation) are the highest elevation of the mine.

These portals will be back-sloped with rock-fill, soiled, and revegetated, but adit plugs will

not be needed.

Concrete adit plugs in the service and conveyor adits will be designed to avoid the possibility

of large-scale mine discharge or outflow from one of the adits. Seepage around the adit

plugs is expected to be small and no "pool" of water will build up behind the service adit

portal cover material, which is designed to allow seepage to dissipate through the rock-fill

and overlying cover. Detailed design of adit plugs will be based on principles outlined in

Appendix J.

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The post closure water management plan has been modified to include adit plugs to seal the mine and funnel mine water into the pipeline. Adit plugs will be grouted to minimize leakage. The service and conveyor adit plugs will be constructed during the closure period (1 to 2 years after cessation of mining).

A preliminary assessment of the use of tunnel plugs at the mine has been conducted (Appendix J). This report discusses the types of plugs used in the industry and recommends installation of a concrete plug with additional pressure grouting (as required) as the most promising alternative. Numerous final design details will be required before final locations and construction requirements are detailed. Design parameters for the plugs include:

- Local geology;
- Potential head (potential height of water above the plug including inflows from the surface); and
- Integrity of the local rock.

# General Adit Plug Construction Sequence

After final location and design parameters are identified and the mine has entered the reclamation phase, the plugs will be constructed in the following sequence:

- 1. Final Design Phase. Detailed engineering and other design parameters will be identified in the final phase of mining taking into account any changes to the mine or new information that would affect final design.
- 2. Consolidation Grouting. Used to consolidate the local rock surrounding the plug location to reduce hydraulic gradient across the plug and reduce the possibility of piping.
- 3. Plug Construction. It will be important to specify the type and quantity of cement/concrete products to insure a successful plug. Bulkheads and water diversion pipes will be required to redirect any water during plug construction. The plugs will require a continuous pour to eliminate the possibility of a cold joint.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 4. Contact Grouting. After the concrete plug has been poured, additional contact

grouting will be required to fill and seal the space between the concrete and rock

contact.

Estimated costs for the adit plugs are \$100,000 each (\$200,000 for two).

7.2.2 Adit Plugging/Mine Flooding

Even though water will flow out of the mine, a portion of the underground workings will still

flood and hold water. Mine flooding likely will reduce the amount of dissolved oxygen in

mine water, particularly in the deeper portions of the mine. Copper in the orebody is present

mainly as the copper sulfide minerals bornite and chalcocite. When exposed to high levels of

oxygen, such as occurs in the ventilated mine presently, these sulfide minerals oxidize and

release copper and sulfate into the mine water. After the mine is sealed, the amount of air

movement into the mine and the amount of oxygen available for oxidation of copper sulfide

minerals will be greatly reduced. Adit plugging and sealing of the mine portals, therefore, is

expected to result in an improvement in mine water quality by reducing the amount of

leaching of copper minerals.

7.2.3 Natural Attenuation

Natural attenuation is the treatment of water by natural materials and natural processes.

Because of natural attenuation the transport of copper in groundwater is slowed or precluded

by physical and chemical removal mechanisms such as adsorption and mineral precipitation.

Natural attenuation occurs in groundwater in the vicinity of the Troy tailing facility and will

also occur in groundwater percolating through the mine.

From 1993 to 2004 Asarco and Genesis Inc. disposed of water from the underground

workings primarily by discharge to the decant ponds (also known as the barge ponds).

Although copper is typically present in mine-water at concentrations of approximately 0.05

to 0.1 mg/L, groundwater adjacent to the decant ponds, in the impoundment, and around the

perimeter of the impoundment is much lower, typically 0.005 mg/L or less. For comparison,

surface water in Lake Creek adjacent to the impoundment typically contains approximately

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0.003 mg/L copper. In spite of the higher copper concentrations discharged to the impoundment, copper concentrations in Lake Creek and in monitoring wells installed in the

impoundment vicinity have not increased measurably as a result of the discharge (see

Summit, 1999; Parametrix, 1999). These observations suggested that a high level of natural

attenuation of copper was occurring in groundwater near the decant ponds.

Studies to evaluate copper attenudation at the tailing facility are summarized in Appendix C.

Site investigation has show that copper is effectively attenuated within a few inches in the

fine grained material at the tailing facility. Additionally, copper attenuation would be

expected to continue into the indefinite future as the materials and conditions required for

copper attenuation (inorganic carbon in the form of carbon dioxide from air and carbonate

from minerals in soil/tailing; silica from abundant silicate minerals in soil/tailing; and

organic carbon from plant material) are essentially limitless in the environment.

As described in Appendix C, the distance over which attenuation occurs is documented to be

very short. Attempts to document concentration gradients in groundwater have been made

(see description of Phase 2 and 2B monitoring well installation in Appendix C) but no

elevated copper concentrations have been found due to the very short distance over which

attenuation occurs.

7.3 TAILING FACILITY

7.3.1 Storm-water Drainage

Presently, the main surface of the impoundment generally drains from the outer dike

eastward towards the edge of the impoundment area. All storm-water runoff from the

impoundment surface currently enters the decant ponds where it percolates to groundwater

with no discharge to surface water. During final reclamation, this system of storm-water

handling will be maintained. Any surface contouring will be localized and will maintain the

general direction of storm-water flow toward the decant (barge) pond. As described in

Section 4.14.6, the decant ponds will be regraded but will continue to provide wetlands

7-9

habitat following final reclamation.

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The majority of the storm-water runoff from the face of the primary dike is currently captured by the toe ponds. A minor amount is dispersed on the surrounding native ground.

cuptured by the toe points. It initial unlount is dispersed on the surror

This system will be maintained following final reclamation.

7.3.2 Toe Ponds

The four toe ponds located along the perimeter of the toe of the primary dike were installed

in 1983 to contain storm-water runoff. The toe ponds are numbered and named toe ponds 1,

2, 3, and 4 from south to north. The southern toe pond (a.k.a., toe pond #1) is typically dry.

Toe ponds 2, 3, and 4 usually contain standing water and are often used by moose that

inhabit the area. Water from toe ponds 2, 3, and 4 is sometimes pumped to the impoundment

at a rate of approximately 500 gpm for 2 to 3 weeks during the spring snowmelt period of

each year. This pumping is done to keep the ponds low when the mill is fully running but it

will not be necessary after mill closure. During the summer of 2005 with the mill in

operation, the toe ponds were not pumped as described above. The toe pond levels remained

fairly constant.

After reclamation of the impoundment surface, water pumped from the toe ponds will be

used to sprinkle or flood irrigate a small portion of the impoundment near the toe ponds; or

may be piped directly to the decant ponds.

7.3.3 Springs

Currently, a sump and pumping system ("enviro-pump") is employed to capture groundwater

that emerges downhill from the toe ponds. The system is operated by float switch that keeps

the approximately 500-gallon sump from overflowing. Water removed from the sump is

pumped to the number 2 toe pond. This system will be maintained and operated until water

quality is suitable for release. During the summer of 2005, Genesis Inc. turned off the

automatic timer. The pump now runs continuously, with water being pumped back into toe

pond 2, with a pumping rate of  $\sim$ 3 gallons/minute.

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8.0 MAINTENANCE AND MONITORING PLAN

**8.1 REVEGETATION** 

Preliminary revegetation at the Troy Mine has been monitored by Sindelar (1996) and

Stephens (2000a, 2000b). Monitoring to date has documented results of revegetation trials

on the tailing facility surface and tree planting success on various mine disturbances.

Undocumented revegetation monitoring by mine company personnel and consultants has

been conducted periodically to ensure that seeded areas are providing erosion control.

Revegetation monitoring will continue during the pre-closure and closure phases of the

operation. Monitoring will be designed to evaluate:

• Adequacy of revegetation to limit off-site sedimentation;

• Woody plant survival rates;

• Vegetation vigor to assess whether supplemental fertilization may be desirable;

• Diversity of seeded and invading species;

• Competition between herbaceous and woody species to determine if lower

herbaceous seeding rates or other measures are desirable to promote woody species

survival and growth;

• Noxious weed presence; and

• Prevalence of hydrophytic species in areas designated for wetlands establishment.

Revegetation techniques and seed mixes/planting rates may be modified, with agency

approval, to reflect evaluations of revegetation monitoring.

If monitoring identifies areas with poor germination or growth, high woody plant mortality

or other problems, these areas will be evaluated to ascertain causal factors. If necessary,

reclamation techniques will be modified to address identified problems and the site

remediated by reseeding, interseeding, supplemental planting or fertilization, or other

mitigation appropriate to the problem and site. A vegetation monitoring plan (Appendix G)

8-1

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 March 17, 2006

will be utilized to determine success of revegetation and identify areas that need reseeding or

modification to the revegetation plan.

**8.2 WATER** 

Appendix F contains the proposed water monitoring plan for surface water and groundwater

in the area. This monitoring plan will be continued during and after reclamation until

Genesis Inc., MDEO, and USFS agree that monitoring is no longer necessary. It is

anticipated that this monitoring plan will be modified as needed to reflect the changes in

operations or identifies water resource issues.

Figure F-1 shows locations of proposed groundwater and surface water monitoring sites.

Monitoring wells are shown on Exhibit A and Figure F-1. Table F-2 summarizes monitoring

site information.

Genesis has been monitoring groundwater at several locations peripheral to the mine in

Emma and Weasel Gulches and an unnamed tributary below the South Adit portal for the last

several years. This monitoring has been coordinated with DEQ and the Forest Service to

evaluate potential sources of seepage of groundwater from the mine area as the mine flooded.

These monitoring sites are proposed to be continued to evaluate potential mine water

influence on groundwater.

8.3 ADIT PLUGS

Little or no maintenance of the plugs is expected.

**8.4 TAILING FACILITY** 

Monitoring of the impoundment area for water and air quality parameters will be especially

important during the years of actual reclamation activity and immediately following the

completion of the reclamation phase. Ongoing geotechnical monitoring will continue until

Genesis Inc. and MDEQ agree to discontinue monitoring. A geotechnical monitoring

program utilizing the inspection protocol outlined in Appendix H will be conducted on an

8-2

annual basis.

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Best management practices will be utilized such as silt fences and water diversion ditches as well as water application for dust suppression. The existing water monitoring plan will continue to be used to monitor Lake Creek. The duration of monitoring will depend on the results. Upon demonstration that a steady state of no measurable impact has been achieved it is anticipated that routine monitoring will no longer be required.

Genesis Inc. P.O.Box 1660 Troy, MT 59935 (406) 295-5882 9.0 SCHEDULE

Reclamation of the Troy Mine will be accomplished in three phases: pre-closure, closure,

and post-closure. As described in Section 1, evaluation and development of certain elements

of the reclamation plan (primarily related to management of mine drainage and revegetation

of the tailing facility) are ongoing and final details of these elements are not available.

Although dependent on metal prices and other factors, Genesis Inc. plans to operate the mine

for approximately 4 to 5 years prior to final closure. This pre-closure phase of mine

operation will allow ample time to evaluate, modify if necessary, and design final

reclamation elements prior to closure of the mine.

During the mine closure phase (estimated to require 2 years after cessation of mining) all

facility removal and regrading, revegetation, and maintenance of short-term components of

the water management plan will be conducted. During the post-closure phase (estimated to

be 2 to 5 years after cessation of mining), the long-term water and adit plug effectiveness

monitoring will be conducted.

9.1 PRE-CLOSURE (OPERATIONAL) TASKS

Pre-closure tasks include the ongoing monitoring, testing, and evaluations needed to

complete design of reclamation elements (primarily short-term water management plan) prior

to closure of the mine. These tasks will be completed prior to final mine closure (anticipated

to occur within the next 5 years, but may occur sooner or later depending on metal prices).

Pre-closure tasks include:

1. Engineering design of adit plugs;

2. Continuation of surface water, mine-water, groundwater, aquatic biological, and

revegetation monitoring; and

3. Noxious weed management.

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#### 9.2 CLOSURE TASKS

Closure tasks will occur within 2 years following final cessation of mining and will include facility removal and regrading, revegetation, and maintenance of short-term components of the water management plan. Specific tasks include:

- 1. Removal of fuel tanks;
- 2. Removal of the water supply at the plant site;
- 3. Removal of fences;
- 4. Rerouting of surface pipelines from the adit plug to the tailing lines below the tailing thickener (e.g. steel tailing lines);
- 5. Reclamation of maintenance sump;
- 6. Removal of sewage treatment facility;
- 7. Sealing and reclamation of mine openings;
- 8. Installation of adit plugs;
- 9. Removal of the mill and plant site facilities and regrading and revegetation of the area;
- 10. Regrading and revegetation of topsoil and subsoil stockpiles and borrow areas;
- 11. Capping and revegetation of the tailing facility;
- 12. Noxious weed management;
- 13. Irrigation of impoundment vegetation as needed and removal of irrigation system when it is no longer needed;
- 14. Removal and revegetation of the reclaim water pump station;
- 15. Abandonment of large-capacity make-up wells;
- 16. Monitoring of the pressure head behind the adit plugs to estimate extent of flooding within the underground workings;
- 17. Monitoring of the quantity and quality of mine drainage; and
- 18. Continuation of surface water, mine-water, groundwater, geotechnical, and aquatic biological monitoring.

# 9.3 POST-CLOSURE TASKS

During the post-closure phase (estimated to be 2 to 5 years after cessation of mining), the long-term monitoring will continue:

- 1. Monitoring of the pressure head behind the adit plugs and flow quantity through the pipeline;
- 2. Monitoring of the quantity and quality of mine drainage;
- 3. Continuation of surface water, mine-water, groundwater, geotechnical, and aquatic biological monitoring; and
- 4. Maintenance of the mine water pipeline to the tailing facility.

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#### 10.0 REFERENCES

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# APPENDIX A

MINE FLOODING REPORT

# MINE FLOODING REPORT TROY MINE GENESIS, INC.

In September 2002 Genesis Inc. submitted a study plan to evaluate flooding of the Troy mine to obtain information useful to determining the ultimate hydraulic and geochemical conditions of the mine following permanent closure. The study plan called for monitoring of water level rise following the September 2, 2002 cessation of pumping from the mine, water quality sampling of the mine pool, surface water monitoring of drainages peripheral to the mine, and preparation of a map showing the extent of flooding in the mine. It was anticipated that the study would continue for several years and encompass two spring runoff periods. Pumping was restarted in February of 2004 before the mine pool reached the 4220 elevation at the 4East drain point where discharge to the service adit was expected to occur. Additionally only one snowmelt season was monitored. However, considerable data was collected and is reported here.

# Mine Flooding

Water level rise in the mine was recorded by measuring the elevation of the mine pool relative to internal mine survey points. The mine pool rate of rise varied from about a tenth of a foot per day during low flow season to as much as 0.72 feet per day during July following snowmelt infiltration. Table A-1 summarizes the water level rise data for 2003. Figure A-1 shows the calculated mine capacity curve.

# **Mine Water Quality Data**

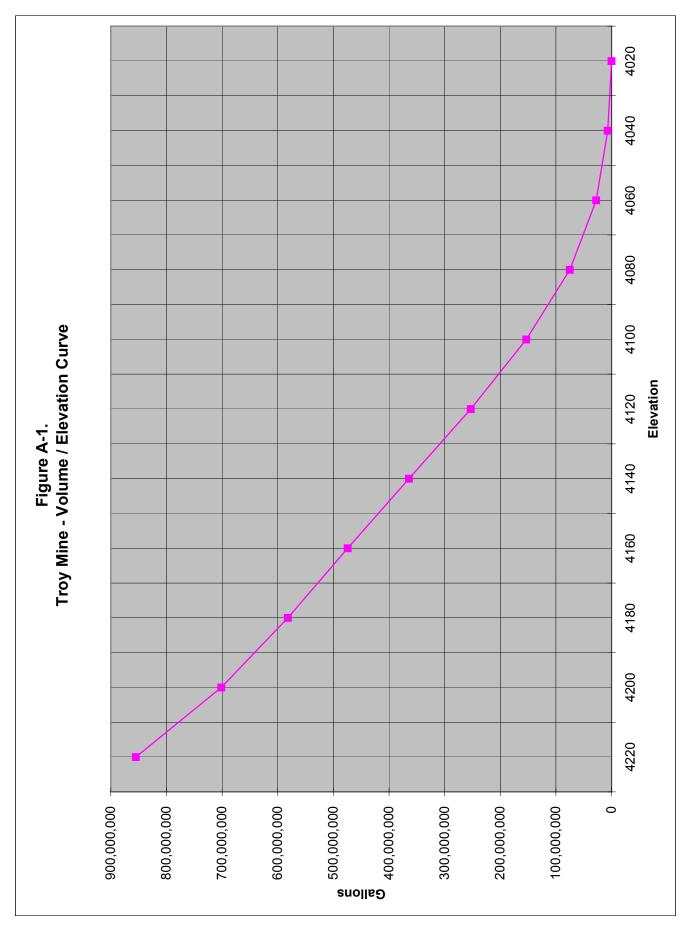
Mine pool water quality data collected in 2003 is shown on Table A-2.

# **External Water Sampling**

External sampling of surface water at the point it was expected to be an expression of groundwater discharge was conducted at several sites peripheral to the mine area. Samples sites were selected by walking the drainages during low flow and sampling at the highest elevation streamflow was observed. Some of the drainages had no baseflow

TABLE A-1. TROY MINE FLOODING DATA GENESIS INC.
TROY MINE
Water Model 2003 Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	<u>Oct</u>	Nov	Dec
Days Per Month	31	28	31	30	31	30	31	31	30	31	30	31
Beginning Water Elevation	4125.0	4129.1	4133.2	4139.4	4145.2	4157.3	4176.3	4198.5	4209.3	4209.3	4201.8	4194.6
Beginning Storage - Gallons	280,815,189	298,671,189	318,831,189	350,079,189	393,279,189	460,239,189	563,919,189	692,482,389	756,763,989	756,763,989	712,123,989	660,283,989
Historical Mine Inflow - Gpm	400	200	200	1,000	1,500	2,000	2,400	1,200	200	200	300	300
Adjustment Factor - %	100.0%	100.0%	100.0%	100.0%	100.0%	120.0%	120.0%	120.0%	100.0%	100.0%	100.0%	100.0%
Estimated Mine Inflow - Gpm	400	200	200	1,000	1,500	2,400	2,880	1,440	200	200	300	300
Inflow - Gallons	17,856,000	20,160,000	31,248,000	43,200,000	000'096'99	103,680,000	128,563,200	64,281,600	30,240,000	22,320,000	12,960,000	13,392,000
Est. Storage - Gallons	298,671,189	318,831,189	350,079,189	393,279,189	460,239,189	563,919,189	692,482,389	756,763,989	787,003,989	779,083,989	725,083,989	673,675,989
Est. Water Elevation	4128.2	4131.8	4137.5	4145.3	4157.4	4177.0	4198.9	4207.2	4211.2	4210.1	4203.1	4196.4
Pump Rate - Gpm	0	0	0	0	0	0	0	0	200	1,500	1,500	1,500
Pump Volume - Gallons	0	0	0	0	0	0	0	0	30,240,000	000'096'99	64,800,000	000'096'99
Ending Storage - Gallons	298,671,189	318,831,189	350,079,189	393,279,189	460,239,189	563,919,189	692,482,389	756,763,989	756,763,989	712,123,989	660,283,989	606,715,989
Ending Water Elevation	4129.1	4133.2	4139.4	4145.2	4157.3	4176.3	4198.5	4209.3	4209.3	4201.8	4194.6	4184.6
Gain / (Loss) - Ft	4.1	4.0	6.3	5.8	12.1	19.0	22.2	10.8	0.0	-7.5	-7.2	-10.0
Average Gain - Ft / Day	0.13	0.14	0.20	0.19	0.39	0.63	0.72	0.35	0.00	-0.24	-0.24	-0.32
Average Gain - In / Day	1.60	1.73	2.42	2.32	4.67	7.60	8.60	4.16	0.00	-2.89	-2.89	-3.85
Mine Outflow Elevation	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0	4225.0
Remaining Storage - Ft	62.6	91.8	85.6	79.8	2.79	48.7	26.5	15.7	15.7	23.2	30.4	40.4
To Tailings Dam												
Mine Pumping - Gpm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	700.0	1,500.0	1,500.0	1,500.0
Service Adit Outflow - Gpm Total To Tailings - Gpm	300.0 300.0	320.0 320.0	340.0 340.0	448.0 448.0	650.0 650.0	<u>785.0</u> 785.0	768.0 768.0	<u>576.0</u> 576.0	<u>417.0</u> 1,117.0	<u>383.0</u> 1,883.0	340.0 1,840.0	300.0



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TABLE A-2. MINE FLOODING WATER QUALITY DATA - 2003

Site	Date	Alk	As -dis	Alk As -dis Ca - dis	ច	CI CO3 Cu - dis	Cu - dis	Fe -dis	Hard	HC03	K - dis	Mg - dis	Mn - dis	Na -dis	NH3-N	Fe-dis Hard HCO3 K-dis Mg-dis Mn-dis Na-dis NH3-N NO3+NO2-N Pb-dis pH Sb-dis SiO2	Pb -dis	Hd	Sp-dis		SO4 TDS Zn -dis	TDS Z	'n -dis
		(mdd)	(bbm)	(mdd) (mdd) (mdd) (mdd) (mdd) (mdd)	(mdd)	(mdd)	(mdd)	(mdd)	(ppm) (ppm)	(mdd)	(mdd)	(mdd)	(mdd)	(bbm)	(bbm)	(bbm)	(mdd)	(hd)	(mdd)	(mdd)	(ppm) (ppm)		(bbm)
Mine Discharge	15-Apr-03 78.0	78.0	0.004	30.0	1.1	<2.0	0.051	<0.010	109.0	78.0	<2.0	8.4	0.011	<2.0	<0.050	1.1	<0.003	7.6	0.016	5.3	29.0	147.0	<0.010
Mine Discharge	25-Aug-03 72.0	72.0	0.008	26.0	<1.0	<2.0	0.079	<0.020	89.0	72.0	<2.0	6.1	0.049	<2.0	<0.10	0.83	<0.003	7.9	0.007	5.0	21.0	127.0	0.013
Emma Gulch	26-Aug-03 30.0 <0.003	30.0	<0.003	7.5		<1.0 <2.0 <0.001		<0.020	27.0	30.0	<2.0	2.1	<0.005	<2.0	0.23	<0.10	<0.003	7.6	7.6 <0.003	9.2	<2.0	62.0	<0.010
Ross Creek-1 (RC-1) 26-Aug-03	26-Aug-03	70.0	20.0> 0.07	24.0	<1.0	<2.0	<0.001	<0.020	78.0	70.0	<2.0	4.4	<0.005	<2.0	69.0	1.1	<0.003	6.7	<0.003	6.2	8.3	111.0	<0.010
Weasel Lake	26-Aug-03 4.0 <0.003 <1.0 1.2 <2.0 0.0019	4.0	<0.003	<1.0	1.2	<2.0	0.0019	0.16	<5.0	4.0 <2.0	<2.0	<1.0	0.013	<2.0	0.10	<0.10	<0.003	6.1	<0.003 6.1 <0.003 1.8 2.4	1.8	2.4	52.0	<0.010

during one or more of the sampling periods and samples were not collected. Water quality data from these sampling sites are contained in Table A-2. Sample site locations are shown on Exhibit A.

# **Mine Mapping**

A map of the mine and a cross section showing the relation of the mine workings to the overlying topography is shown in Exhibit D.

# APPENDIX B

# REVEGETATION STATUS REPORT

# TROY MINE TAILINGS IMPOUNDMENT REVEGETATION MONITORING – 2003 TROY MINE, LINCOLN COUNTY, MONTANA

# Prepared for:

Revett Silver Company
Troy Unit
Genesis, Inc.
P.O. Box 1660
Troy, Montana 59935

# Prepared by:

L. Dean Culwell WESTECH Environmental Services, Inc. P.O. Box 6045 Helena, Montana 59604

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#### 1.0 INTRODUCTION

The Troy Mine, located in Lincoln County in northwestern Montana, operated from 1981 to 1993 with mine development from 1979 to 1981. Since 1993 the mine has not been producing but has been maintained in an inactive mode in anticipation of rising metal prices and subsequent reopening.

Tailings from the underground copper/silver mine were deposited in a three-cell impoundment located between Lake Creek and Montana Highway 56. The center cell (Cell 2) of the tailings impoundment has reached design capacity while the two remaining cells (1 and 3) have capacity for additional tailings deposition once the mine resumes production.

Reclamation activities conducted to date on the tailings facility include seeding and planting of the embankment and establishment of three reclamation test plots on Cell 2. Additionally, during 2003, borrow material was placed on the portions of Cell 2 not previously reclaimed. These areas will be topsoiled and revegetated in 2004, completing reclamation of Cell 2.

WESTECH conducted an evaluation of revegetation on the tailings embankment face in 1985 measuring cover and production on seven 0.5 meter<sup>2</sup> plots (Culwell *et al.* 1987). The embankment, seeded between 1980 and 1983, was well vegetated with cover ranging from 25 to 95 percent. Timothy and smooth brome were the dominant grasses and alsike clover had high cover. Aboveground annual production ranged from 131.7 to 611.3 grams/meter<sup>2</sup> averaging 268.3 grams/meter<sup>2</sup> (about 2400 pounds/acre).

An experimental reclamation program initiated in 1995 on 80 to 90 acres in Cell 2 was designed to revegetate untopsoiled tailings with irrigation and livestock grazing in combination with scattered borrow material/topsoil "islands". Initial results of this program were presented by Sindelar (1996). Seeded species, primarily timothy, red clover and white Dutch clover, responded to irrigation and fertilization, providing forage for cattle in the experimental area. A supplemental seeding in fall 1995 increased diversity. Trees were planted at the rate of 500 trees/acre on uncapped tailings in May 1996 (Stephens Timber Consulting 2000a). Due to concerns raised by the Montana Department of Environmental Quality (DEQ) about the tailings as a plant growth medium in lieu of previously salvaged topsoil (Plantenberg 1997), the study was discontinued in 1997. Two seasons of soil building by livestock grazing and soil amendments were insufficient to create a suitable plant growth medium from the tailings and, when irrigation was discontinued, plant cover was much reduced. Ocular observations of trees planted in uncapped tailings indicated

fair survival but seedlings exhibited stunting, desiccation and sun scald due to harsh site conditions (Stephens Timber Consulting 2000a).

#### 2.0 METHODS

Eight monitoring plots were established in the three Cell 2 revegetation test plots on September 30 and October 1, 2003 (Figure 1). Four plots were randomly placed in Test Plot A, and two plots each in Test Plots B and C. Dean Culwell (WESTECH) and Bruce Clark (Revett Silver) conducted monitoring on September 30 with Culwell conducting the monitoring on October 1. Weather was clear with cool mornings and warm afternoons.

#### 2.1 Cover

Cover was estimated on 0.01-acre circular plots laid out with a measuring tape marking plot center and plot perimeter with pin flags. Ground cover was visually estimated for bare ground, rock, litter, lichens, moss and basal vegetation to total 100 percent, and canopy cover was estimated for total non-stratified vegetation. Canopy cover was also estimated for each morphological class (perennial grasses, annual grasses, perennial forbs, annual/biennial forbs, subshrubs, shrubs and trees) and for each vascular plant species. Species not readily identifiable in the field were collected, pressed and keyed out in the office. Nomenclature follows USDA Forest Service (1987). Common and scientific names of species recorded on plots are listed in Appendix A.

"Incidental" species outside the 0.01-acre plot but within a 0.1-acre plot centered on the smaller plot were recorded as supplementary diversity data.

# 2.2 Tree Density

Tree density was measured on the 0.1-acre circular plot established for recording incidental species. Trees were recorded by species and segregated as planted or volunteer trees.



• TM03-01 REVEGETATION MONITORING PLOT

WESTECH
Environmental Services, Inc.
P.O. Box 6045
Helena, Montana 59604

SCALE:1"=1000'
DATE: 04/14/04
DRAWN BY: DC
CHECKED BY:
FILE: TROY04A01.DWG

TROY MINE TAILING IMPOUNDMENT REVEGETATION MONITORING SITES

REVETT SILVER COMPANY - TROY UNIT

FIGURE 1

#### 3.0 RESULTS

Test Plot A was sampled with four 0.01-acre plots and Test Plots B and C were sampled with two 0.01-acre plots each. Table 1 presents canopy cover data by sample plot and Test Plot. Table 2 presents tree density data for the eight plots. Appendix B includes 2003 field forms and Appendix C presents photographs of each plot.

#### 3.1 Test Plot A

Test Plot A covers about 30 acres (Figure 1). A 12-inch layer of subsoil from the east impoundment borrow site was placed on the tailings, and the site was seeded in 1997. Fertilizer and mulch were applied to the alluvial coversoil. Almost 20,000 tree seedlings were planted in 1997, 1998 and 1999. Species planted included ponderosa pine, white pine, Douglas-fir, lodgepole pine and Englemann spruce. In addition to the seedlings, more than 200 larger trees were transplanted to the site from the alluvial borrow site. Initial establishment was aided by irrigation with mine water.

For ground cover, rock (40 percent) and bare ground (21 percent) combined dominate the surface of Test Plot A with 25 percent litter cover. Moss cover is about 10 percent and basal vegetation is 4 percent (Table 1).

Total nonstratified vegetation canopy cover averages 44 percent comprised primarily of perennial grasses (25 percent cover) with about 12 percent cover of annual/biennial forbs and 9 percent cover of perennial forbs. Hard fescue is the dominant grass at 20 percent cover with smooth brome the only other grass over 1 percent, averaging about 4 percent cover.

Yellow sweetclover and white sweetclover together account for about 9 percent cover with the native annual, autumn willow-herb, at 2 percent cover. Introduced perennial forbs include spotted knapweed (6 percent cover), and white Dutch clover and oxeye daisy each with 1 percent cover.

Shrubs average 1 percent cover with trees at almost 2 percent cover.

There are about 100 surviving planted trees per acre, mainly ponderosa pine and Douglas-fir. Total tree density, however, is nearly 300 trees per acre with volunteer black cottonwood averaging nearly 200 trees per acre. Black cottonwood has been severely hedged by wildlife.

Fifty species are present on monitoring plots in Test Plot A, including 8 grasses, 19 perennial forbs, 10 annual/biennial forbs, 3 subshrubs, 6 shrubs and 4 trees.

Table 1.

Percent canopy cover and site parameters for eight 0.01-acre plots (11.8 feet radius) in test plots sampled in reclamation at Revett Silver Company's Troy Mine Tailings Impor 2003.

			TEST PLOT A	<b>∀</b>			TEST PLOT B	_		TEST PLOT
		Plot N	Plot Number		Mean	Plot N	Plot Number	Mean	Plot Number	ımber
	TM03-05	TM03-06	TM03-07	TM03-08	n=4	TM03-03	TM03-04	n=2	TM03-01	TM03-02
SITE DARAMETERS										
Slope (percent)	0-10	0-5	0-1	0-1		0-1	0-1		0-1	1-0
Aspect (degrees)	Flat	Flat	Flat	Flat		Flat	Flat		Flat	Flat
Topography	Bench	Bench	Bench	Bench		Bench	Bench		Bench	Bench
Configuration	Undul	Straight	Straight	Straight		Straight	Undul		Straight	Straight
Soil	Alluvium	Alluvium	Alluvium	Alluvium		Alluvium	Alluvium		Topsoil	Topsoil
Investigator	DC	DC	DC	DC		DC/BC	DC		DC	DC/BC
GROUND COVER										
Bare Ground	25	25	15	20	21.25	15	15	15.00	09	65
Rock	36	32	09	40	40.25	09	61	09'09	8	8
Litter	20	31	22	22	25.00	10	15	12.50	15	13
Lichens	0.3	0.3		0.3	0.23	0.3	0.3	08'0	1	0.3
Moss	15	2	4	15	9.75	12	9	00'6	12	10
Basal Vegetation	4	4	4	3	3.75	3	3	3.00	4	4
VEGETATION STRUCTURE										
(nonstratified cover)										
Total Vegetation	43	44	53	37	44.25	36	41	38.50	45	44
Perennial Graminoids	27	33	22	18	25.00	33	36	34.50	40	34
Annual Graminoids										
Perennial Forbs	15	4	12	5	9.00	3	9	4.50	7	12
Annual/Biennial Forbs	4	2	70	15	11.50	6.0	0.3	08'0	0.3	0.3
Subshrubs				0.3	0.08					
Shrubs		-	3		1.00	0.3		0.15		
Trees	2	1	7	1	1.50	0.3	0.3	08'0		
CEASS/SPECIES										
NATIVE PERENNIAL GRAMINOIDS										
Agropyron caninum	×	X			×					
Carex rossii		×		1	0.25					
TOTAL NPG	×	×	0.0	1.0	0.25	0.0	0.0	0.00	0.0	0.0

Table 1.

Percent canopy cover and site parameters for eight 0.01-acre plots (11.8 feet radius) in test plots sampled in reclamation at Revett Silver Company's Troy Mine Tailings Impot 2003.

			TEST DI OT	<			TEST BIOT B			TEST DI OT
		Plot N	Plot Number		Mean	Plot N	Plot Number	Mean	Plot N	Plot Number
	TM03-05	TM03-06	TM03-07	TM03-08	n=4	TM03-03	TM03-04	n=2	TM03-01	TM03-02
INTRODUCED PERENNIAL GRAMINOIDS										
Agrostis stolonifera										×
Bromus inermis	2	10	4	2	4.50	2	0.3	1.15	4	ဇ
Dactylis glomerata			_		0.25	0.3	0.3	0:30	-	
Festuca duriuscula	25	25	15	15	20.00	30	35	32.50	35	30
Festuca pratensis						×		×		×
Phleum pratense			-	×	0.25		0.3	0.15		
Poa compressa	0.3	×	-	×	0.33	~	0.3	0.65	0.3	٢
Poa pratensis	×	×	-	×	0.25					
TOTAL IPG	27.3	35.0	23.0	17.0	25.58	33.3	36.2	34.75	40.3	34.0
NATIVE PERENNIAL FORBS										
Achillea millefolium		×	-	×	0.25		×	×		×
Anaphalis margaritacea			X		X					
Antennaria neglecta			0.3		0.08					
Antennaria racemosa	×				×					
Apocynum androsaemifolium		×			×					
Aster laevis	×				×					
Campanula rotundifolia	0.3		_		0.33					
Fragaria vesca	×				×					
Fragaria virginiana		×	×		×					
Penstemon wilcoxii		×	0.3		80.0	×		×		0.3
TOTAL NPF	0.3	×	2.6	×	0.73	×	×	×	0.0	0.3
INTRODUCED PERENNIAL FORBS										
Centaurea maculosa	12	4	9	3	6.25		4	2.00	3	8
Centaurea nigra						×		×		
Chrysanthemum leucanthemum	0.3		1	2	0.83	×	1	0.50	×	7
Cirsium arvense										0.3
Hypericum perforatum	×				×	×	0.3	0.15		
Medicago sativa									0.3	
Plantago lanceolata	×	×	2		0.50					0.3
Rumex acetosella						2		1.00	0.3	
Tanacetum vulgare	×		×	×	×					
Taraxacum officinale		X	0.3		0.08				0.3	
Trifolium hybridum	0.3	X			0.08	×		×		×
Trifolium pratense			×		×					
Trifolium repens	3		_		1.00	_	_	1.00	3	2
TOTAL IPF	15.6	4.0	10.3	5.0	8.73	3.0	6.3	4.65	6.9	11.6

Table 1.

Percent canopy cover and site parameters for eight 0.01-acre plots (11.8 feet radius) in test plots sampled in reclamation at Revett Silver Company's Troy Mine Tailings Impor 2003.

			TEST PLOT	A			TEST PLOT	В	I	TEST PLOT
		Plot N	Plot Number		Mean	Plot N	Plot Number	Mean	Plot Number	ımber
	TM03-05	TM03-06	TM03-07	TM03-08	n=4	TM03-03	TM03-04	n=2	TM03-01	TM03-02
NATIVE ANNUAL/BIENNIAL FORBS										
Epilobium paniculatum	0.3	9	0.3	0.3	1.73	0.3	0.3	0:30	0.3	0.3
Madia glomerata									×	
Microsteris gracilis	×				×					
Polygonum douglasii									×	
TOTAL NAF	0.3	6.0	0.3	0.3	1.73	0.3	0.3	0:30	0.3	0.3
INTRODUCED ANNUAL/BIENNIAL FORBS										
Cirsium vulgare		×			×					
Dianthus armeria						×		×		
Filago arvensis	0.3	×	0.3	0.3	0.23	0.3		0.15		×
Melilotus alba	×	×	7	10	3.50					
Melilotus officinalis	0.3	1	15	4	5.08	X		×		
Potentilla norvegica										×
Tragopogon dubius			0.3		0.08					
Trifolium arvense	0.3		×		0.08					
Trifolium dubium	က				0.75					
Verbascum thapsus	×	×	1	0.3	0.33	×		×		
TOTAL IAF	3.9	1.0	20.6	14.6	10.03	0.3	0.0	0.15	0.0	×
SUBSHRUBS										
Arctostaphylos uva-ursi			×	0.3	0.08					
Berberis repens	×				×	×		×		
Rubus parviflorus	×				×					
TOTAL SUBSHRUBS	×	0.0	×	0.3	0.08	×	0.0	×	0.0	0.0
SHRUBS										
Ceanothus velutinus	×	×	×		×	0.3		0.15		
Physocarpus malvaceus		×	0.3	×	0.08					
Rosa gymnocarpa	×	×	0.3	×	0.08	×		×		
Salix sitchensis		×	2		0.50					
Spiraea betulifolia	×	1	×		0.25	×	×	×		
Symphoricarpos albus	×	0.3	0.3	×	0.15	×		×		
TOTAL SHRUBS	×	1.3	2.9	×	1.05	0.3	×	0.15	0.0	0.0

Table 1.

test plots sampled in reclamation at Revett Silver Company's Troy Mine Tailings Impor 2003. Percent canopy cover and site parameters for eight 0.01-acre plots (11.8 feet radius) in

		Т	TEST PLOT A	4		TE	TEST PLOT B	В	TE	TEST PLO1
		Plot Number	umber		Mean	Plot Number	mber	Mean	Plot Number	ımber
	TM03-05	TM03-06 TM03-07 TM03-08	TM03-07	TM03-08	n=4	TM03-03 TM03-04	TM03-04	n=2	TM03-01 TM03-02	TM03-02
TREES										
Abies grandis						×		×		
Larix occidentalis		×			×					
Picea engelmannii						×		×		
Pinus contorta						×	×	×	×	×
Pinus monticola										×
Pinus ponderosa	2	-	×	×	0.75	0.3	×	0.15		×
Populus trichocarpa	0.3	×	1	_	0.58	0.3	0.3	0:30		
Pseudotsuga menziesii	×		1	×	0.25	×		×		×
TOTAL TREES	2.3	1.0	2.0	1.0	1.58	9.0	0.3	0.45	×	×
TOTAL VEGETATION (Stratified)	49.7	48.3	61.7	39.2	49.73	37.8	43.1	40.45	47.5	46.2

# Footnotes:

Trace cover values were assigned 0.3 percent for each 0.01-acre canopy cover estimation plot.

X represents incidental species recorded in a 0.1-acre plot (37.2 feet radius) centered on each 0.01-acre plot (11.8 feet radius).

Binomials follow USDA Forest Service (1987).

Table 2.

Tree density by species in three test plots in reclamation at Revett Silver Company's Troy Impoundment, 2003.

					Tree	s per 0.1-a	Trees per 0.1-acre circular plot	ar plot			
		T	TEST PLOT A	A		L	TEST PLOT B	В	IL	TEST PLOT C	
		Plot N	Plot Number		Mean	Plot N	Plot Number	Mean	Plot Number	ımber	
	TM03-05	TM03-06 TM03-07	TM03-07	TM03-08	n=4	TM03-03	TM03-03 TM03-04	n=2	TM03-01 TM03-02	TM03-02	
SPECIES											
Abies grandis						_		0.50			
Larix occidentalis		4			1.00						
Picea engelmannii						1		02'0			
Pinus contorta						4	3	3.50	2	_	
Pinus monticola										2	
Pinus ponderosa	2	4	2	5	4.50	4	3	3.50		2	
Populus trichocarpa	12	8	49	10	19.75	10	11	10.50			
Pseudotsuga menziesii	3	1	4	10	4.50	10		2.00		-	
TOTAL TREES	22.0	17.0	55.0	25.0	29.75	30.0	17.0	23.50	2.0	9.0	

#### 3.2 Test Plot B

Test Plot B covers about two acres (Figure 1) and was reclaimed similarly to Test Plot A with 6-18 inches of alluvial subsoils comprising the plant growth medium. Test Plot B was seeded in 1999.

As with Test Plot A, rock (60 percent cover) and bare ground (15 percent cover) dominate the ground surface. Litter cover is low at 12 percent cover, mosses provide 9 percent ground cover and basal vegetation is 3 percent.

Total nonstratified vegetation canopy cover averages about 38 percent for the two plots, slightly less than Test Plot A at 44 percent. Compared to Test Plot A, perennial grass cover is higher on Test Plot B (34 percent versus 25 percent) with lower cover of other morphological classes. The most striking difference is the low cover of annual/biennial forbs (yellow sweetclover and white sweetclover) compared to Test Plot A.

Hard fescue dominates the site averaging about 32 percent cover, with smooth brome at 1 percent cover. Other species with at least 1 percent cover include spotted knapweed, sheep sorrel and white Dutch clover.

Tree density averages 235 trees per acre of which 130 trees per acre were planted and 105 trees per acre are volunteer black cottonwood. Other than black cottonwood, Douglas-fir, ponderosa pine and lodgepole are relatively common. Of interest, the more mesic-site species grand fir and Engelmann spruce are present on one plot.

Thirty-one species are present on the two monitoring plots in Test Plot B including 6 perennial grasses, 9 perennial forbs, 5 annual/biennial forbs, 1 subshrub, 4 shrubs and 6 tree species.

#### 3.3 Test Plot C

Test Plot C (about 2 acres) differs from Test Plots A and B in that 18 inches of stockpiled topsoil was placed over the tailings. The site was seeded, fertilized, mulched and planted with trees similarly to Test Plots A and B. Seeding and planting was conducted in 1999.

As would be expected using topsoil instead of alluvial borrow material, ground cover of rock is much lower at 8 percent cover on Test Plot C than the 40 and 60 percent rock cover on Test Plots A and B, respectively.

Conversely, bare ground cover is much higher at 62 percent than the test plots using alluvial borrow material. Litter comprises 14 percent ground cover, mosses provide 11 percent cover and basal vegetation is 4 percent.

Total nonstratified vegetation canopy cover is comparable to the alluvial borrow material test plots at about 44 percent. As with the other test plots, perennial grasses were by far the dominant morphological class averaging 37 percent cover. Perennial forbs average about 10 percent cover with only a trace of annual/biennial forb cover. Shrubs and trees were not recorded on the two cover plots but were observed within Test Plot C.

Hard fescue dominates Test Plot C at about 32 percent cover, with smooth brome at about 4 percent cover. No other grasses exceeded 1 percent cover. The perennial forb component is dominated by spotted knapweed at about 6 percent cover. The only other perennial forb with more than 1 percent cover is white Dutch clover at about 2 percent cover.

Planted tree density is low at 55 trees per acre comprised of lodgepole pine, western white pine, ponderosa pine and Douglas-fir.

Diversity, as measured by total number of species recorded on the 0.1-acre plots, is the lowest of the three test plots at 26 species. These include 6 species of grasses, 11 species of perennial forbs, 5 species of annual/biennial forbs and 4 trees.

#### 4.0 DISCUSSION

Revegetation on the three test plots is comparable between plots in terms of total vegetation cover and composition of dominant species. Total canopy cover ranged from 38 percent on Test Plot B to 44 percent on Test Plots A and C. The dominant grass on all three sites is hard fescue with mean canopy cover ranging from 20 to 32 percent. The only other grass averaging greater than one percent cover on the test plots is smooth brome with relatively low cover ranging between 1 and 4 percent. With the exception of hard fescue, most species originally seeded when the test plots were established in 1997, 1998 and 1999 have very low cover. This contrasts with data collected in 1985 on the embankment face when timothy, smooth brome and redtop were dominant grasses. It is likely that the species in the seed mix requiring more moisture were favored by initial irrigation of the embankment and impoundment surface. Discontinuance of irrigation has favored the more drought-tolerant hard fescue with corresponding decreases in more mesic-site species.

The dominant perennial forb on all three test plots is the noxious weed, spotted knapweed, with cover ranging from 2 to 6 percent. Other noxious weeds present include oxeye daisy, Canada thistle, common St. John's-wort, common tansy and black knapweed. It is anticipated that noxious weed cover will increase until forest cover increases measurably. As forest cover increases, noxious weed cover should decrease.

The seeded species, white Dutch clover, is persisting on all three test plots, although at relatively low cover between 1 and 2 percent.

Yellow sweetclover and white sweetclover total about 9 percent canopy cover on Test Plot A but are absent or have low cover on Test Plots B and C.

Test Plot A is the only test plot with more than trace cover of shrubs. Six native shrub species are present on Test Plot A including Sitka willow, white spirea, common snowberry, mallow ninebark, baldhip rose and mountain balm. Four shrubs are present in monitoring plots on Test Plot B while no shrubs were recorded on sample plots in Test Plot C.

Tree cover is low on all three test plots, with about 2 percent cover on Test Plot A and less than 1 percent on Test Plots B and C.

Tree density varied widely among the three test plots. Test Plot A has a tree density of 297.5 trees per acre of which 100 trees are planted species and 197.5 are volunteer black cottonwood. Ponderosa pine and Douglas-fir are the next most common at 45 trees per acre each. Test Plot B has 235 trees per acre, 130 planted trees and 105 black cottonwood. Douglas-fir, ponderosa pine and lodgepole pine are the most prevalent planted species. Test Plot C has 55 trees per acre of planted species, primarily western white pine, lodgepole pine and ponderosa pine. Given planting rates of 500 trees per acre for Test Plot A and 250 trees per acre for Test Plots B and C (Stephens Timber Consulting 2000a), survival is about 20 percent on Test Plots A and C and about 50 percent on Test Plot B. It should be noted, however, that initial tree planting was non-uniform (a clumpy distribution) and sampling methodology (a few small plots) may not accurately reflect overall tree density. Stephens Timber Consulting (2003) found survival rates of 72 percent on Test Plot B (alluvium) and 50 percent on Test Plot C (topsoil) using a staked tree method.

Black cottonwood has become well-established on Test Plots A and B, both alluvial borrow material sites, but was not recorded on monitoring plots on the topsoil site (Test Plot C). Most cottonwood are severely browsed by wildlife and are short (shrub-like) with multiple stems. If

cottonwood can grow beyond browsing height, assuming normal or above-normal precipitation and/or reduced wildlife browsing, the alluvial material sites should develop into a mixed black cottonwood/conifer forest. Because cottonwood establishes most readily from seed on rocky, sparsely vegetated sites, it is less likely that it would be a significant component of topsoiled reclamation unless it is intentionally planted.

Diversity (total number of species recorded on sample plots within each test plot) was much higher on Test Plot A at 50 species than Test Plot B (31 species) or Test Plot C (26 species). This discrepancy may be due to a number of factors including: 1) sample size (4 sample locations in Test Plot A versus 2 each in Test Plots B and C); 2) sample location (proximity of monitoring plots to transplants which contained more native species); 3) age of test plots (Test Plot A is one to two years older than Test Plots B and C); 4) number of transplant sites containing native species (Test Plot A contains more transplant sites than Test Plots B or C); 5) source of borrow material (Test Plot A borrow material may have contained more native plant propagules than material placed on Test Plot B); and 6) location (Test Plot A is closer to and just downslope from native forest compared to Test Plots B and C).

Stephens Timber Consulting (2000a, 2000b, 2003) has cited compacted soils as a problem in tree planting and survival. During 2003 revegetation monitoring, it was also noted that both alluvium and topsoil were compacted. It is likely that these compacted soils adversely affect survival, growth, productivity and water availability leading to dominance of more shallowly rooted, drought-tolerant species such as hard fescue. Ripping subsoil and topsoil following placement, or using soil spreading techniques that minimize compaction would likely enhance revegetation success.

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# **APPENDICES**

## **APPENDIX A**

### **SPECIES LIST**

Appendix A. List of vascular plant species recorded in test plots on tailings impoundment reclamation at the Revett Silver Company Troy Mine, Lincoln County, Montana, 2003.

BINOMIAL	CODE	COMMON NAME
NATIVE PERENNIAL GRAMINOIDS		
Agropyron caninum	Agr can	Bearded wheatgrass
Carex rossii	Car roi	Ross sedge
INTRODUCED PERENNIAL GRAMINOIDS		
Agrostis stolonifera	Agr sto	Redtop
Bromus inermis	Bro ine	Smooth brome
Dactylis glomerata	Dac glo	Orchard-grass
Festuca duriuscula	Fes dur	Hard fescue
Festuca pratensis	Fes pra	Meadow fescue
Phleum pratense	Phl pra	Common timothy
Poa compressa	Poa com	Canada bluegrass
Poa pratensis	Poa pra	Kentucky bluegrass
NATIVE PERENNIAL FORBS		
Achillea millefolium	Ach mil	Common yarrow
Anaphalis margaritacea	Ana mar	Pearly-everlasting
Antennaria neglecta	Ant neg	Field pussytoes
Antennaria racemosa	Ant rac	Raceme pussytoes
Apocynum androsaemifolium	Apo and	Spreading dogbane
Aster laevis	Ast lae	Smooth aster
Campanula rotundifolia	Cam rot	Roundleaf harebell
Fragaria vesca	Fra ves	Woods strawberry
Fragaria virginiana	Fra vir	Virginia strawberry
Penstemon wilcoxii	Pen will	Wilcox's penstemon
INTRODUCED PERENNIAL FORBS		
Centaurea maculosa	Cen mac	Spotted knapweed
Centaurea nigra	Cen nig	Black knapweed
Chrysanthemum leucanthemum	Chr leu	Oxeye daisy
Cirsium arvense	Cir arv	Canada thistle
Hypericum perforatum	Hyp per	Common St. John's-wort
Medicago sativa	Med sat	Alfalfa
Plantago lanceolata	Pla lan	Buckhorn plantain
Rumex acetosella	Rum ace	Sheep sorrel
Tanacetum vulgare	Tan vul	Common tansy
Taraxacum officinale	Tar off	Common dandelion
Trifolium hybridum	Tri hyb	Alsike clover
Trifolium pratense	Tri pra	Red clover
Trifolium repens	Tri rep	White Dutch clover
	r	

### Appendix A. (Continued)

BINOMIAL	CODE	COMMON NAME
NATIVE ANNUAL/BIENNIAL FORBS		
Epilobium paniculatum Madia glomerata Microsteris gracilis Polygonum douglasii	Epi pan Mad glo Mic gra Pol dou	Autumn willow-herb Cluster tarweed Pink microsteris Douglas knotweed
INTRODUCED ANNUAL/BIENNIAL FORBS		
Cirsium vulgare Dianthus armeria Filago arvensis Melilotus alba Melilotus officinalis Potentilla norvegica Tragopogon dubius Trifolium arvense Trifolium dubium Verbascum thapsus	Cir vul Dia arm Fil arv Mel alb Mel off Pot nor Tra dub Tri arv Tri dub Ver tha	Bull thistle Deptford pink Field filago White sweetclover Yellow sweetclover Norwegian cinquefoil Common salsify Hare's foot Least hop clover Flannel mullein
SUBSHRUBS		
Arctostaphylos uva-ursi Berberis repens Rubus parviflorus SHRUBS	Arc uva Ber rep Rub par	Kinnikinnick Creeping Oregon-grape Thimbleberry
Ceanothus velutinus Physocarpus malvaceus Rosa gymnocarpa Salix sitchensis Spiraea betulifolia Symphoricarpos albus	Cea vel Phy mal Ros gym Sal sit Spi bet Sym alb	Mountain balm Mallow ninebark Baldhip rose Sitka willow White spirea Common snowberry
TREES		
Abies grandis Larix occidentalis Picea engelmannii Pinus contorta Pinus monticola Pinus ponderosa Populus trichocarpa Pseudotsuga menziesii	Abi gra Lar occ Pic eng Pin con Pin mon Pin pon Pop tri Pse men	Grand fir Western larch Engelmann spruce Lodgepole pine Western white pine Ponderosa pine Black cottonwood Douglas-fir

Nomenclature follows USDA Forest Service (1987).

## **APPENDIX B**

### FIELD FORMS - 2003

VEGETATION INVENTORY FORM - COVER					
Project: GENESIS INC TROY MINE		Slope (%) 0-1		Plot size: 0.01 acre, (11.8-foot	
Sample ID: TM03 - 01		Aspect FLAT		Condition/trend	
Location: TEST PL	OT C	Topography BENC	1	Soil TOPSOIL	(114)
Date: 9 / 3 o	/2003	Configuration FLAT	T-UNEVEH SURFACE	Photo # 4-5	
Crew: D. CUL	WELL	Elevation		Community type FES	CUE
		CLASS/SPEC	CIES COVER	·	
Bare ground 60 (%)	Rock 8 (%)	Litter 15 (%)	Lichens / (%)	Moss 12 (%)	Basal veg 4 (%)
	·. · · · · · · · · · · · · · · · · · ·				Total veg 45 (%)
PERENNIAL GRASSES 40 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS 7 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS (%)	SUBSHRUBS (5) (%)
FES DUR 35		TRIPEP 3		EPI PAN T	
BROINE 4		CEN MAC 3			
POA COM T		MED SAT T			SHRUBS 💪 (%)
PAC GLO 1		TAR OFF T		·	
		RUM ACE T			
				2 12.	
		•	•	-	
					TREES (%)
		* .			
	` .				
		and the state of t			0.1 acre = T (Pyza
Incidental species in 0.1 ac Craminoids	cre (37.2-foot radius): Forbs	Woody Plants	COMMENTS: 500	indurated	
	Chr leu	Pincon	too hard	to dia	
er e	Mad glo	Α	2 pro in	0.1 acre pla	rone
	Pol dou		m vide		
· : : : : : : : : : : : : : : : : : : :					
			WILDLIFE: MODSE  CHEENE POUP	reck pellet	3

		VEGETATION INVEN	TORY FORM - COVER		
Project: GENESIS INC TROY MINE		Slope (%) <i>D - /</i>		Plot size: 0.01 acre, circular (11.8-foot radius)	
-	Sample ID: TM03 - O2 Aspec			Condition/trend	
Location: TEST P	LOT 2	Topography BENCH	1	Soil TOPSOIL	
Date: 9 / 3 a	/2003	Configuration FLAT	- UNEVEN SURFACE	Photo # 6	
Crew: D.C.V.L.W.E	ELL/B. CLARK	Elevation		Community type FE	SCUE
	• .	CLASS/SPEC	CIES COVER		
Bare ground 65 (%)	Rock <b>8</b> (%)	Litter /3 (%)	Lichens T (%)	Moss 15 (%)	Basal veg 4 (%)
					Total veg 44 (%)
PERENNIAL GRASSES 34 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS 12 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 7 (%)	SUBSHRUBS (%)
FES DUR 30		PLA LAN T		EPI PAN T	
BROINE 3		CEN MAC 8			*
PDA COM 1		TRI REP 2			SHRUBS (%)
		CHRLEU 1			
		CIR ARV T			
		PEN WIL T			-
	<u> </u>	:			
					`
	<u> </u>				TREES O (%)
	•				TREES (%)
					0.1 acre =
Incidental species in 0.1 as Graminoids  FES CUE  FES PRA  Evanue clump  fact - wide 44  Agr alp	re (37.2-foot radius): Forbs  Fil arv  Tr. hyb  Ach mil  Pot NOR?	Woody Plants Pin MON Pin PON Pin CON Pise wen	Density: Pin mon HI Pin con 1 Pse man 1		
	· .		WILDLIFE: gove p	oop, deer a elle	pellets

VEGETATION INVENTORY FORM - COVER					
Project: GENESIS INC TROY MINE		Slope (%) 8-/		Plot size: 0.01 acre, (11.8-foot	
Sample ID: TM03 - 4	23	Aspect FLAT		Condition/trend NA	
Location: TEST PL	.OT B	Topography BENC	Н	Soil Rocky (b.	orrow)
Date: 9 / 3 d	/2003	Configuration 578A	IGHT-UNEVEN	Photo # 7	
Crew: D. CHLWEL	4B. CLARK	Elevation		Community type	
		CLASS/SPEC	CIES COVER		· .
Bare ground 15 (%)	Rock 60 (%)	Litter / 0 (%)	Lichens <b>T</b> (%)	Moss 12 (%)	Basal veg 3 (%)
		· · · · · · · · · · · · · · · · · · ·			Total veg 36 (%)
PERENNIAL GRASSES 33 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS 3 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 7 (%)	SUBSHRUBS (%)
FES DUR 30		TRI REP 1	: .	FIL ARV T	
BROINE 2		Rumace 2		EPIANG T	
FOA COM 1					SHRUBS T (%)
DACGLO T					CEA VEL T
	· · · · · · · · · · · · · · · · · · ·				11.12%
		·			
		: .			TREES 7 (%)
		,			POPTRI T
					PIN PON T
		· ·			
					0.1 acre -
Incidental species in 0.1 a Graminoids Coonse Sescue	cre (37.2-foot radius):  Forbs  NEL OFF  TRI HYB  HMP PER  Ver HAL  CEN NIG-  PEN WILL  CHR LEU  SPI BET	ABI GRA	Density: Ping Pse Pic Pin Abi	sho 1 con 1111 con 1111 med HATH	M03-01 d. 02
	DIA ARM		WILDLIFE: a ,	deer, elk	

	VEGETATION INVEN	ITORY FORM - COVER			
Project: GENESIS INC. – TROY MINE	Slope (%) 0 - 1		Plot size: 0.01 acre, circular (11.8-foot radius)		
Sample ID: TM03 - 04	Aspect FLAT		Condition/trend	NA	
Location: TEST PLOT B	Topography BENO	7H	Soil BOPRO	w - gravelly(Cobbly	
Date: 9 / <b>30</b> /2003	Configuration CND I	ILATING	Photo # 8		
Crew: D. CULWELL	Elevation		Community type	FESCUE	
	CLASS/SPE	CIES COVER	• .		
Bare ground /5 (%) Rock 6/ (%)	Litter /5 (%)	Lichens T (%)	Moss 6	(%) Basal veg 3 (%)	
			T	Total veg 41 (%)	
PERENNIAL 36 (%) ANNUAL GRASSES (%)	PERENNIAL FORBS 6 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNI/ FORBS	AL (%) SUBSHRUBS Ø (%)	
FES DUR 35	CENMAC 4		EPI PAN T		
PHL PR4 T	CHR LEU 1				
POA COM T	HYP FER T	·	"	SHRUBS (%)	
DAC GLO T	TRI REP 1				
BROINE T					
,					
				<u></u>	
				TREES 7 (%)	
				POPTRI T	
				`	
Incidental species in 0.1 acre (37.2-foot radius):  Graminoids  Forbs  ACH MIL	Woody Plants PIN CON SPI BET	COMMENTS: rery	CFE)	O.1 acre =  Species at  transplant sites;  Psemen  spi Bet	
,	PIN PON	POP TRI PIN CO PIN PO		SUM ALB FRA VIR ROSALL GUM BER REP	
		WILDLIFE: Lew, ol	k	meinly Paper in fails	

		VEGETATION INVEN	TORY FORM - COVER		
Project: GENESIS INC. TROY MINE	<del>-</del>	Slope (%) 0 - 10		Plot size: 0.01 acre, (11.8-foot	
Sample ID: TM03 - 0	5	Aspect FLAT		Condition/trend ~A	
Location: TEST 1	PLOT A frome	Topography BENC	ЭН	Soil Borrow gravelly	loam 0-4"
Date: 10 / 01	/2003 +0 nc	Configuration und	ulating	Photo # 14-15	
Crew: D. Cul	WELL	Elevation		Community type FES	CHE WITREES
		CLASS/SPEC	CIES COVER		
Bare ground 25 (%)	Rock 36 (%)	Litter 20 (%)	Lichens ア (%)	Moss 15 (%)	Basal veg 4 (%)
					Total veg 43 (%)
PERENNIAL GRASSES 27 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS /5 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 4 (%)	SUBSHRUBS 💪 (%)
FES DUR 25		CEN MAC 12		EPIPAN T	· .
BROINE 2		CHRLEU T		MEL OFF T	
POA COM T		TRIREP 3		TRIARV T	SHRUBS (%)
		TRIHYB T	•	TRI DUB 3	
		CAM ROT T		FIL ARV T	
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
	· · · · · · · · · · · · · · · · · · ·				
					TREES 2_ (%)
	· · · · · · · · · · · · · · · · · · ·			:	PIN PON 2
			· · · · · · · · · · · · · · · · · · ·		POPTRI T
					0.1 acre = 2-3
Incidental species in 0.1 a Graminoids  AGR LAN  POA PRA	Forbs TANUUL ASTER LAE MIC GRA	ves .	COMMENTS:  DENSITY (0.14  PIN PON  PSE MEN  POPTRI H  WILDLIFE: deer	M 11	

		VEGETATION INVEN	TORY FORM - COVER		<del>Service to the service of the servi</del>
Project: GENESIS INC. TROY MINE	-	Slope (%) 6 - 2-		Plot size: 0.01 acre (11.8-foot	
Completion THOS				Condition/trend NA	
Location: TEST (	PLOT A	Topography BENC	Н	Soil Burrow gravelly	no sample
Date: 10 / 0	/2003	Configuration FLAT	UNEVEN	Photo # 16,17	
Crew: D. Cul	WELL	Elevation		Community type FES	CHE MTREES
		CLASS/SPEC	CIES COVER		
Bare ground 25 (%)	Rock 35 (%)	Litter 31 (%)	Lichens $\mathcal{T}$ (%)	Moss 5 (%)	Basal veg 4 (%) Total veg 44 (%)
PERENNIAL 33 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS 4 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 7 (%)	SUBSHRUBS (%)
FES DUR 25	. 1	CEN MAC 4		EPIPAN 6	-
BROINE 10				MELOFF 1	-
					SHRUBS / (%)
					SPI BET 1
					SYMALB T
-					
	-				
				-	
	:				TREES / (%)
					PIN PON 1
7		,			
				•	0.1 acre =
Incidental species in 0.1 a Craminoids  AGF CAN POA PRA CAR ROS POA LOM	Forbs TAR OFF VER THA APO AND FIL ARV MEL ALB	Woody Plants POP TRI ROS ACT GYM LAC OCC CEA VEL SALIX SITCH PHY MAL	Trees  DENSITY (D.1.  PIN PON II  LAR DCC I  POP TRI T  PSE MEN	H 111	over & diversity

	· .	VEGETATION INVEN	TORY FORM - COVER			
Project: GENESIS INC. TROY MINE	•	Slope (%) 0 - 1			Plot size: 0.01 acre, circular (11.8-foot radius)	
Sample ID: TM03 - 07 Aspect FLAT			Condition/trend NA			
Location: TEST P	LOT A	Topography BENC	H .	Soil borrow-g	ravely loam sample	
Date: 10 / 01		Configuration STRA	IGHT- UNEVEN	Photo # 18,19		
Crew: D. Cul	NELL	Elevation		Community type		
		CLASS/SPEC	CIES COVER			
Bare ground 15 (%)	Rock 50 (%)	Litter 27 (%)	Lichens 7 (%)	Moss 4 (%)	Basal veg 4 (%)	
					Total veg 53 (%)	
PERENNIAL 22 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS 12 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 20 (%)	SUBSHRUBS () (%)	
FES DUR 15		CEN MAC 6		MEL OFF 15		
POA COM 1		PLA LAN 2		TRA DUB T		
POA PRA 1		TRI REP Witch 1		MELALB 4	SHRUBS 3 (%)	
BRO INE 4		CHRLEN 1		VERTHA 1	PHY MAL T	
PACGLO 1		ACHMIL 1		FILARY T	SYM ALB T	
PHL PRA 1		TAR OFF T		EPI PAN T	SALIX SIT 2	
·		PEN WIL T			ROS AM T	
		CAM ROT 1				
		ANT NEG T				
					TREES 2 (%)	
					POP TRI 1	
					PSEMEN I	
					0.1 acre = 2	
Incidental species in 0.1 a <u>Graminoids</u>	cre (37.2-foot radius): Forbs  TAN VU⊢	Woody Plants		both yellow a		
	ANA MAR FRA VIR	CEA VEL SPI BET ARC UVA	DENSITY (OIL			
	TRI PRA TRI ARV	ALO VITA		the the the I	W M M M M	
	The purple Aster 15 a Penstem	pv1	WILDLIFE: deer, elk	rellets		

		VEGETATION INVEN	TORY FORM - COVER		
Project: GENESIS INC. – TROY MINE Slope (%)		Plot size: 0.01 acre, circular (11.8-foot radius)			
Sample ID: TM03 - O	8	Aspect FLAT		Condition/trend NA	
Location: TEST PL	OT A	Topography RENC	H	Soil Borrow gravelly	leam-nosample
Date: <b>DCT</b> / <b>O</b> ]	/2003	Configuration 57841	6HT - WNEVEN	Photo # 21 - 24	
Crew: D. CUL	WELL	Elevation		Community type FES	CHE W/TREES
		CLASS/SPE	CIES COVER	· .	
Bare ground 20 (%)	Rock <b>40</b> (%)	Litter 22 (%)	Lichens T (%)	Moss 15 (%)	
PERENNIAL GRASSES /8 (%)	ANNUAL GRASSES (%)	PERENNIAL FORBS _5 (%)	PERENNIAL FORBS (%)	ANNUAL/BIENNIAL FORBS 15 (%)	Total veg 37 (%)  SUBSHRUBS 0 (%)
FES 15	GRADES (10)	CHR LEN 2	1000	MEL OFF 4	30031R003 - (70)
BROINE 2		CENMAC 3		VER THA T	
LAREX ROS 1				EPI PAN T	SHRUBS 7 (%)
		<u>- 1, 1 </u>		FIL ARY T	ARC UVA T
				MEL ALB 10	
-					A
:				:	
				. 6	
					TREES / (%)
	•			,	POP TRI 1
					0.1 acre = 3
Incidental species in 0.1 ac Graminoids POK COM PHL PRA POA PRA	Forbs VERTHA TANUUL	Woody Plants PSE MEN SUM ACB PHY MAN PIN PON ROS ACT GYM		ut ut ut tht	
			WILDLIFE: deer 9	eir	·

# APPENDIX C

### **MONITORING PLOT PHOTOS - 2003**



PLOT TM03-01 – TEST PLOT C

**SEPTEMBER 30, 2003** 



PLOT TM03-02 – TEST PLOT C

**SEPTEMBER 30, 2003** 



PLOT TM03-03 – TEST PLOT B

**SEPTEMBER 30, 2003** 



PLOT TM03-04 – TEST PLOT B

SEPTEMBER 30, 2003



PLOT TM03-05 – TEST PLOT A

OCTOBER 1,2003



PLOT TM03-06 – TEST PLOT A

OCTOBER 1,2003



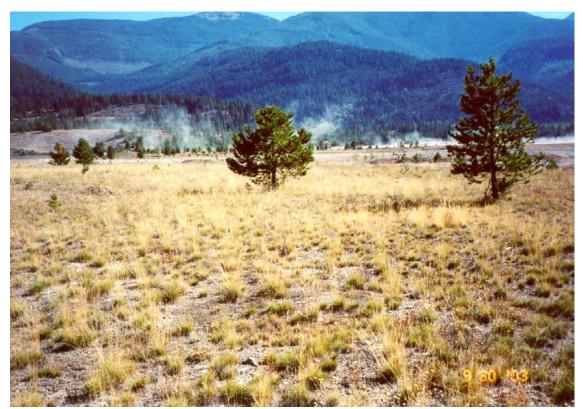
PLOT TM03-07 - TEST PLOT A

OCTOBER 1,2003



PLOT TM03-08 - TEST PLOT A

OCTOBER 1,2003



TEST PLOT C SHOWING LARGER TRANSPLANTED TREES



TREE ESTABLISHMENT ON TAILINGS EMBANKMENT – SEEPAGE COLLECTION POND BELOW EMBANKMENT TOE



UNSOILED TAILINGS ON CELL 2



END-DUMPING ALLUVIAL MATERIAL ON CELL 2 – FOREGROUND SHOWS BOUNDARY BETWEEN REVEGETATED ALLUVIUM AND TAILINGS

### **APPENDIX D**

### STEPHENS TIMBER CONSULTING REPORTS

January 13, 2000

David K. Young ASARCO Incorporated 274 Union Blvd, Suite 450 Lakewood, Colorado 80228-1836

Re: Status Report for Troy Unit Tailing Area and Upper Adit Area Reclamation

Dear Dave,

Stephens Timber Consulting was contracted for initial conifer seedling planting in the Troy Unit Mine Tailing Area in the spring of 1995 and conifer and shrub seedling planting in the Upper Mine Adit Area in the fall of 1997. The following is an account of STC reclamation activity in these areas to date organized under the headings Chronological Activity, General Observations and Results, and Recommendations.

#### **Chronological Activity:**

#### A. Tailing Area

- 1. April & May, 1995 A total of 9650, 2-0 bareroot conifer seedlings, primarily Ponderosa Pine (PP) with some Whitepine (WP), were hand planted at about 500 trees per acre in a non-uniform (clumpy) distribution. The area planted was the tailing dam face, south side to the dike access road on the southwest side of dam. 5000 Tiller Nets were used for animal browse control on the PP.
- 2. May, 1996 A total of 3150, 2-0 bareroot conifer seedlings were hand planted, including 2000 Scotch Pine (SP), PP and WP in the uncapped tailing at about 500 trees per acre, with the remaining PP interplanted on the dam face. The tailings area planted was in the southwest portion of Section II. A survival stake row of 50 random seedlings along a specific azimuth was installed to quantify survival in the uncapped tailing.

#### B Upper Adit

- 1. November, 1997 A total of 3000 bareroot conifer and deciduous seedlings were hand planted, including 1000 ES (2-0), 500 Alpine Fir (AF) (3-0), 500 WP (2-0), 300 Mountain Maple (1-0), 300 Black Cottonwood (1-0), 200 Willow (Salix sp.) (1-0) and 200 Black Hawthorn (1-0). All seedlings were root dipped in EM inoculum and fertilized with the RTI Bio-Pak teabags. The planting density and distribution was highly variable depending on location of plantable sites (many areas of coarse rock lacking fines). The site was also broadcast seeded with a grass/ forb/shrub mixture using a hand cyclone spreader at about 25lbs per acre. A total 40 lbs of shrub seeds in the mixture included Rocky Mountain Maple, Kinnikinnick, Mountain Ash, Beargrass and Black Elderberry, which are all natives found near this site. Shredded straw was machine blown onto some vehicle accessed areas.
- 2. November, 1999 A total of 750 bareroot conifer seedlings were hand planted, including 500 ES (3-0) and 250 AF (2-0). Areas unplanted in 1997 were targeted and distribution was again variable depending on location of plantable sites. All seedlings were root dipped in EM inoculum and fertilized with the RTI Bio-Pak teabags. A survival stake row of 50 random seedlings was installed to quantify survival with half the stakes above the adit road extension on the southeast periphery of the reclaimed area and the other half across the central terraces.

#### **General Observations and Results**

#### A. Tailing Area

1. Dam Face and Toe Ponds (about 50 acres) - Efforts to establish conifers on the dam face have been generally successful. Mostly PP were planted on the drier south and southwest exposures, and there was concern about big game browse damage from, primarily deer, wintering on these low snowpack and early opening warm slopes. Tiller netting was used during the spring, 1995 & 1996 plants to protect the seedling's terminal and lateral buds from ungulate browsing during early spring green up. Browse damage turned out to be minimal on adjacent, unnetted seedlings and subsequent netting was discontinued. The heavy winter snows of 1996-1997 also caused addition damage to some trees from the tiller netting and these were staked and the nets cut away in spring of 1997.

Survival was not quantified but ocular observations indicated good survival, with WL the most difficult specie to establish. The upper most lift was the harshest site and required subsequent interplanting. Seedlings exhibited better health and vigor planted next to bunch grasses than in exposed tailing spots. There was some concern about damage to seedlings from confined cattle ranging on the dam face.

Most of this early test area has been covered by pit run alluvium as reclamation has continued. An observation was made during the fall, 1999 planting that some original surviving trees left in uncapped tailing depressions were showing increased growth and vigor, possibly due to adjacent soil development and biotic "infection", as well as fertilizer response.

3. Capped Tailing in Section II (about 25 acres) - Initial survival of seedlings in the pit run alluvium appear to be good, with the exception of DF planted in 1998, which were infected with water mold (Botrytus sp) from the nursery and had high mortality. Bareroot seedlings initially have shown better vigor and growth than the 4 cubic inch container stock, but were much more difficult to plant due to compacted fill. The alluvium became very compacted by many trips over the fill by both haul trucks, which had to back over the previously placed fill to avoid sinking in the tailing, and the large bulldozer used to spread the alluvium. Possible use of alternate equipment such as belly dumps, and ripping and/or tilling fill material before planting should be investigated. Thorough soaking of a portion of the capped area with sprinklers to the point of saturation was tried, and made spade penetration much easier.

Most of the capped tailing had shredded straw machine blown over the area, along with grass/forb broadcast seeding prior to planting. Vegetative competition has not been a problem yet. Islands of alluvium and topsoil were constructed in the capped area and some large woody debris (logs and stumps) were incorporated into the area. Larger trees and native vegetation were also transplanted into the area in large loader buckets. These incorporated materials serve to provide substrates for soil microorganisms and inoculate surrounding alluvium.

- 4. Topsoil Stockpile Approximately half of the topsoil stockpile west of the toe ponds from the Section II/III divider dike south was planted in 1997. This revegetated grassland required some ground scalping to reduce vegetative competition with the seedlings. Portions of the stockpile were surprisingly compacted and a topsoil recovery pit was difficult to excavate because of compacted fine clay materials. Lower sections of the pit appeared to be in an anaerobic condition. While survival seems to be good, future monitoring for survival should be done.
- 5. Test Plots Both test plots, especially the topsoil, were significantly compacted by heavy equipment and some areas were unplantable using a planting spade, so seedling distribution was very clumpy. Prior to planting, the test plots were fertilized with 16-16-16 at 150 lbs per acre and a grass/forb mixture was broadcast seeded at 25 lbs per acre. In the weeks before planting the alluvium was watered with sprinklers while the topsoil was watered with a water truck, which may partially explain the higher compaction problems on the topsoil. Smaller soil particle size may also have contributed to compaction problems.

B. Upper Adit - Portions of the 9-acre reclamation area that experienced the seed germination failure should be reseeded with a grass/forb/shrub mixture in the spring/summer of 2000, as soon as the snow has melted from the site. Much of the remaining unstocked area is unplantable by traditional methods. Use of 4 cubic inch container stock with a steel bar for opening a planting hole could be tried in these areas. Grass plugs are available from local nurseries and could be planted with the conifer plugs in difficult to establish areas. The stake row should be surveyed in September, 2000 for the one year stocking survey. Based on results in fall of 2000, alternative options and cost analysis could be reviewed for year 2001.

The preceding report is intended as an overview of the reclamation activities that Stephens Timber Consulting organized. The report attempts to document specific actions that were taken both spatially and temporally. Many activities were conducted to determine possible future actions without rigorous testing and the associated costs. Some conclusions may require further investigation and analysis to determine their validity.

If you have any questions or comments, please feel free to contact me.

Sincerely,

Ken Stephens, Manager STEPHENS TIMBER CONSULTING

**KLS** 

Attachments: Maps (2)

cc: Frank Duval

November 16, 2000

Frank Duval Genesis, Inc. P. O. Box 1660 Troy, Montana 59935

Re: 1st Year Survival Stake Row Results

Dear Frank.

The following report is an update to the January 13, 2000 "Status Report for Troy Unit Tailing Area and Upper Adit Area Reclamation Report" written by this author for David Young of ASARCO, Incorporated. This report summarizes 1<sup>st</sup> year stake row results from planted seedlings in the Tailing Area test plots and the Upper Mine Adit.

On October 26, 2000 Stephens Timber Consulting collected survival stake row data from the Troy Tailing test plots and the Upper Mine Adit. Conifer seedlings were planted in November, 1999 and a total of 50 randomly selected seedlings were staked and recorded in each area. All stakes were found and the trees were well into bud set after one growing season. Growing conditions began with adequate winter snow cover followed by excellent spring moisture until early July. The remainder of the summer into September was characterized by extreme drought conditions including almost no moisture and above average temperatures. Overall conditions were moderate to highly stressful on these exposed sites. During data collection individual stakes were driven deeper into the ground if needed, painted with orange aerosol on stake tops for better visibility and renumbered with a black permanent marker.

#### Results:

On the Tailing Section II topsoil test plot, total seedling survival was 60%, which included five stressed trees (10%). Three of the stressed trees were Lodgepole with dead terminal leaders. Of the three specie staked, Ponderosa Pine exhibited slightly higher survival than Whitepine and Lodgepole Pine. The main cause of mortality was non-establishment (16%), missing (10%), and the remainder (14%) perished during the growing season. First year growth was poor with some stunting and chlorosis evident.

At the Upper Adit site much of the area proved unplantable using traditional methods. Soil movement is still active as evidenced by horizontal and leaning stakes, although many areas are becoming more stable with time as slopes reach their angle of repose. The idea of biotic infection from the edges and remnant islands in the central terrace area was supported by the stake row results, with good survival near the edges. The only surviving tree in the central terrace area was near an undisturbed island of soil and many native volunteer conifer seedlings were present around these islands. The presence of moss in areas of straw mulch was also noted.

#### Recommendations:

Soil samples should be taken from the tailing test plots to identify possible causal factors for survival differences. Both chemical (including pH) and physical (particle size) analysis would be of interest. The stake rows should again be monitored in the fall of 2001 for the two-year analysis. Fixed plots on both tailing test areas to record total biotic assemblages should also be considered to provide additional data on the growth sites. The idea of infection islands on the upper adit to mimic natural colonization of severe sites could be used to expedite re-vegetation. This would include incorporation of additional organic material such as straw mulch and large woody debris (rotting logs) in islands on the central terrace area and subsequent seeding, planting and inoculation with microbes. The use of the Douglas Fir beetle kill logs is also recommended for tailing reclamation as infection sites and to provide micro-sites and habitat for a variety of organisms. The recommendations made in the January report are still valid and broadcast seeding of grass and shrubs on the Upper Adit should be tried next spring.

If you have any questions or comments, please feel free to contact me.

Sincerely.

Ken Stephens, Manager STEPHENS TIMBER CONSULTING

**KLS** 

cc: Dave Young Bruce Clark Doug Parker February 10, 2003

Frank Duval Genesis, Inc. P. O. Box 1660 Troy, Montana 59935

Re: 3rd Year Survival Stake Row Results

#### Dear Frank

The following report is an update to the November 16, 2000 "1st Year Survival Stake Row Results" written by this author for Genesis, Incorporated. This report summarizes 3rd year stake row results from planted seedlings in the Tailing Area test plots. The Troy Mine Upper Adit plots were not inventoried in 2002.

On November 25, 2002 Stephens Timber Consulting collected survival stake row data from the Troy Tailing test plots. Conifer seedlings were initially planted in November, 1999 and a total of 50 randomly selected seedlings were staked and recorded in each test area. All stakes were found and the trees were fully into bud set after the 3rd growing season. Growing conditions in 2001 began with adequate winter snow cover followed by very dry spring moisture. The remainder of the summer into September 2001 was characterized by drought conditions. Growing conditions in 2002 began with low winter snow cover followed by good spring moisture. The summer and fall into November 2002 was characterized by very hot and dry conditions. Overall conditions were very stressful on these exposed sites with the continuation of a four-year drought cycle. During data collection individual stakes were driven deeper into the ground, and if needed, renumbered with a black permanent marker.

#### Results:

On the Tailing Section II topsoil test plot, total seedling survival was 50%, which included one stressed Ponderosa Pine tree (2%). Of the three specie staked, Ponderosa Pine exhibited slightly higher survival than Whitepine and Lodgepole Pine. The main cause of mortality appeared to be moisture related. Second and third year growth was poor with some stunting evident.

On the Tailing Section II pit run alluvium test plot, total seedling survival was 72%, which included eight stressed trees of different specie (16%). Of the four specie staked, Lodgepole Pine and Whitepine exhibited the best survival, followed by Douglas Fir and Ponderosa Pine. Ungulate browse did not seem to be a problem. The main cause of mortality and stress seemed to be lack of moisture. Second and third year growth was generally poor in all specie.

If you have any questions or comments, please feel free to contact me.

Sincerely,

Ken Stephens, Manager STEPHENS TIMBER CONSULTING

KLS

cc: Doug Parker Bruce Clark Dean Culwell

#### **APPENDIX C**

ASSESSMENT OF FATE AND TRANSPORT OF COPPER IN DECANT POND
DISPOSAL SYSTEM – TROY MINE

# ASSESSMENT OF FATE AND TRANSPORT OF COPPER IN DECANT POND DISPOSAL SYSTEM – TROY MINE

Lincoln County, Montana

Prepared for:

**REVETT MINING COMPANY** 424 S. Sullivan Road Veradale, WA 99037

Prepared by:

LAND AND WATER CONSULTING, INC. P.O. Box 8027 Kalispell, MT 59904

January 2004

LWC Project No. 220288

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#### 1.0 INTRODUCTION

The Troy Mine was developed by Asarco in 1979 and went into production in 1981. The mine was operated by Asarco until 1993 when the mine was placed on temporary shutdown. In 1999, the mine was purchased by Genesis Inc., a subsidiary of Sterling Mining Company. Since 1993, Asarco and Genesis Inc. (now Revett Mining Company) have disposed of water from the underground workings by discharge to the tailing impoundment in one of three ways:

- Sprinkler irrigation over the impoundment (primarily during the growing season).
- Discharge to the decant pond (also known as the barge pond).
- Discharge to the Section III pond.

The primary chemical of concern in mine water is copper, which is typically present at concentrations of approximately 0.05 to 0.15 mg/L. For comparison, copper concentrations in Lake Creek adjacent to the impoundment typically range from approximately <0.001 to 0.003 mg/L (higher values occur during high flow events) and the chronic aquatic life standard for copper is approximately 0.004 mg/L (assuming hardness of 35 mg/L). In spite of the higher copper concentrations discharged to the impoundment, copper concentrations in Lake Creek and in monitoring wells installed in the impoundment vicinity have not increased measurably as a result of the discharge (see Summit, 1999; Parametrix, 2003).

The observation that mine water has been discharged with little or no apparent effect on ambient water quality led to the preliminary consideration of continued discharge of mine water to the decant pond as a potential long-term method of mine water disposal (see Revised Reclamation Plan, Sterling 2000). In order for impoundment discharge to be considered further, both the physical flow paths and the transport and attenuation mechanisms for copper in the impoundment/groundwater system have been further assessed. In particular, the flow paths have been identified so that an effective groundwater monitoring system can be installed. Transport and attenuation mechanisms have been assessed to determine the long-term fate of constituents in mine water and the effects of long-term discharge on ambient groundwater and stream quality. This report summarizes results of investigations during 2000 through 2003 that were conducted to characterize the fate and transport of copper and other chemical constituents in mine water disposed in the decant pond at the Troy Mine tailings impoundment.

Fate and transport assessment investigations were conducted in four phases. Results of Phases 1, 2, and 3 have been previously described in Hydrometrics (2001) and Land and Water Consulting, Inc. (LWC) (2002). These previous investigations are described in Section 2 of this report. Phase 4 was conducted in 2003 and is described in Section 3 of this report.

The information gained, and the conclusions or hypotheses made from each phase of the investigation are summarized as follows:

- Phase 1 Groundwater sampling and water quality evaluation demonstrated that although mine water and conservative chemical parameters such as common ions and nitrate is transported to water-bearing zones monitored by existing wells, copper is not transported to the wells. This information appeared to support copper attenuation within a short distance of the decant pond but additional proof of the connection of the decant pond with the deeper permeable zones was desired.
- Phase 3 Groundwater tracer testing was performed to further test the hypothesis that the decant pond is hydraulically connected to the existing wells. Tracer testing and groundwater monitoring associated with the tracer testing suggested that the deeper sand and gravel zones monitored by the existing wells are not the primary flow path for mine water disposed in the decant ponds. Although water quality data continued to suggest a hydraulic connection between the pond and the wells, groundwater was found to respond very slowly to decant pond operations. Based on these investigations it was hypothesized that shallow sand and gravel zones are the primary flow path for mine water (Hydrometrics, 2001).
- Phase 2 Shallow monitoring well installation was conducted to test the hypothesis that shallow sand and gravel zones are the primary flow path for mine water (Hydrometrics, 2001). These borings demonstrated the presence of shallow (less than 40 feet below ground surface (bgs)) saturated sand and gravel zones beneath the decant pond. These wells were found to respond very quickly to changes in decant pond operations (i.e., water levels in the wells rise and fall rapidly in response to changes in the amount of water flowing to the decant pond). In some instances the wells were found to dry up upon curtailing mine water disposal and then resaturate upon resumption of water disposal, suggesting that groundwater in the wells is composed of virtually all mine water. In spite of the short flow path (less than 100 feet) and rapid travel time between the pond and the wells, groundwater sampling demonstrates that copper concentrations in the wells are very low (i.e., 0.004 mg/L) indicating that the bulk of copper attenuation occurs within a very short distances of the decant pond.
- Phase 2b Deep boring/monitoring well installation was intended to 1) complete an operational monitoring well system by providing a deep monitoring well on the west side of the pond; and 2) provide additional information on the presence and location of deeper permeable zones near the pond. Target completion zone for the boring/well was the deep sand and gravel zone encountered at approximately 190 feet bgs in the Irrigation Well on the north side of the pond, however, neither this deep permeable zone nor the shallow gravel zone encountered in Phase 2 drilling were encountered in the Phase 2b deep boring. Information obtained in the deep boring agrees with previous geological evaluations of the area (see Levings et al, 1984) and further demonstrates that the sand and gravel zones are not laterally extensive.
- Phase 4 Geochemical testing was conducted to determine the mechanism and controls of copper attenuation within soils and sediments underlying the decant pond. Empirical data demonstrating removal of copper from mine water by soils and

sediments include 1) visual identification of copper minerals in soils and sediments; 2) electron microprobe identification of copper minerals in soils and sediments; 3) chemical analyses demonstrating enrichment of soils and sediments in copper relative to native soils, tailings, and even ore; and 4) sequential extraction analyses demonstrating that dominant forms of copper in soils are secondary copper minerals and copper adsorbed by organic matter. Water quality correlations between concentrations of copper and other chemical parameters (i.e., redox condition (pe and pH), dissolved silica, dissolved inorganic carbon) in mine water and groundwater also support control of copper attenuation by formation of copper minerals and adsorption by organic carbon.

#### Results of these investigations demonstrate that:

- 1. Groundwater transport of mine water occurs primarily in permeable sand and gravel zones beneath the decant ponds.
- 2. Copper concentrations are quickly attenuated (reduced) to levels below human health and aquatic life standards during groundwater transport within a short distance (ten to one hundred feet) of the decant ponds;
- 3. The mechanisms responsible for copper attenuation include formation of copper minerals and adsorption by organic matter in soils and sediment beneath the decant pond. These mechanisms are expected to continue such that further migration of copper in groundwater is not expected; and
- 4. Because of the limited transport of copper in groundwater, no impacts to ambient groundwater and surface water in the area is expected to occur from continued disposal of mine water in the decant pond.

Based on these findings, the decant ponds appear to constitute an effective, long-term mine water treatment and disposal system.

## 2.0 SUMMARY OF PREVIOUS FATE AND TRANSPORT INVESTIGATIONS

In September 2000, a "Mine Water Fate and Transport Study Plan" (Hydrometrics, 2000a) was developed to guide collection of the information needed to evaluate the fate and transport of mine water disposed at the decant pond. This study plan consisted of the following components:

- Phase 1 Groundwater Sampling and Water Quality Evaluation
- Phase 2 Monitoring Well Installation
- Phase 2b Deep Monitoring Well Installation
- Phase 3 Groundwater Tracer Testing
- Phase 4 Geochemical Evaluation

Results of Phases 1, 2, and 3 have been previously described in Hydrometrics (2001) and LWC (2002). These previous investigations are described in the following Sections 2.1 through 2.5, in the order in which they were conducted. Based on the results of Phase 1, it was decided to conduct Phase 3 before Phase 2 and 4. Results of Phase 4 are described in Section 3.

#### 2.1 Phase 1 – Groundwater Sampling and Water Quality Evaluation (Summer 2000)

An initial obstacle to the study of fate and transport in the system was the absence of any evidence of a copper-bearing mine water-discharge plume in the groundwater system. Therefore, the first phase of the fate and transport study was to locate and identify the groundwater flow paths for discharged mine water through sampling and evaluation of all available monitoring wells and further evaluation of water quality data.

The Study Plan (Hydrometrics, 2000) proposed sampling of nine wells near the impoundment (MW-1, MW-2, MW-3, MW-4, MW-95-5, MW-95-7, MW-95-8, IW-1 (aka Irrigation well), and the Quonset Hut well. All of the wells were sampled on September 7, 2000 except for MW-95-7, which was dry. Wells MW-95-5 and MW-95-8 were sampled by bailing with disposable plastic bailers. The remaining wells were sampled with submersible pumps.

Groundwater quality data, particularly nitrate concentrations (see Table 1) indicate that the groundwater in deeper gravel/sand units near the decant ponds (e.g., units monitored by wells IW-1 and MW-95-8) is derived primarily from mine water disposed in the decant ponds. However, this groundwater does not contain elevated copper concentrations (0.003 mg/L or less). Phase 1 results (Hydrometrics, 20001) support the hypothesis that copper in mine water that is discharged to the decant ponds is strongly attenuated (immobilized) in the groundwater system, probably within a short distance of the decant ponds.

Table 1 September 2000 Water Quality Data									
	Service Adit Minewater	IW-1	QW-1	MW-4	MW-2	MW-3	MW-1	MW95-8	MW95-5
Alkalinity	76	72	24	16	156	124	108	170	170
Arsenic	0.003	< 0.003	< 0.003	< 0.003	0.027	0.01	0.007	< 0.003	0.003
Calcium	23	26	7	4.3	29	36	33	62	47
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	0.056	0.002	0.001	< 0.001	< 0.001	0.001	< 0.001	0.003	0.003
Iron	< 0.020	< 0.020	0.16	< 0.020	< 0.020	7.8	7.7	< 0.020	30
Hardness	81	86	24	15	109	106	103	184	171
Bicarb.	76	72	24	16	156	124	108	170	170
Potassium	<2	<2.0	<2.0	<2.0	2.7	1.1	1.5	2.1	10
Magnesium	5.5	5	1.7	1	8.7	4	5.3	6.9	13
Manganese	0.024	0.081	0.018	0.04	0.25	0/66	0.57	< 0.005	4.8
Sodium	NA	3	<2.0	<2.0	21	5.1	4.9	2.5	7.7
Ammonia	0.1	0.061	< 0.050	0.13	0.43	0.39	0.11	0.051	0.21
Nitrate+nitrite	0.69	0.69	< 0.050	0.11	0.094	< 0.050	0.12	1.2	0.075
Lead	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ph	8.3	7.2	6.3	6.6	7.5	6.9	6.9	7.9	6.3
Antimony	0.009	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Silica	NA	9.3	8.4	7.5	11	28	22	11	65
Sulfate	15	19	3.9	2.6	<2.0	<2.0	9.1	15	7.3
TDS	112	115	52	36	197	166	159	235	361
Zinc	< 0.010	< 0.010	0.32	0.023	< 0.010	< 0.010	< 0.010	0.19	0.35
	ts (mg/L) except nia and nitrate +	pH (std. ur		-		onate and h	ardness (all	mg/L as CaCC	03),

#### 2.2 **Phase 3 – Tracer Testing**

Description and results of tracer testing were provided in the Mine Water Plume Location and Identification Phase 1 Results and Phase 2 & 3 Workplan (Hydrometrics, 2001). The purpose of tracer testing was to test the hypothesis that the deep gravel/sand unit monitored by well IW-1 is the primary flow path for groundwater from the decant pond.

Tracer testing at the decant pond consisted of adding salt (NaCl or sodium chloride) to the mine water flowing to the decant pond to raise the total dissolved solids (TDS), specific conductivity, sodium, and chloride concentrations of water in the decant pond to levels much higher than ambient groundwater. At the same time, monitoring of groundwater in adjacent wells was conducted in order to identify increases in these chemical parameters in groundwater and thus locate the mine water flow path in the groundwater system. The tracer test was conducted during the period of March 8 to May 31, 2001. The general time line and summary of the tracer test was:

- March 8 All wells and decant ponds were sampled to collect baseline water quality data for major ions, nutrients, and metals prior to tracer (salt) addition. Decant pond cell #3 and well MW-97-14 were dry and could not be sampled.
- March 12 Salt addition started at 8:00 am; 5 tons of salt were added by 9:50 am and 10 tons of salt were added by 11:45 am. Salt was added to the reclaim water pipeline at the mill pond. At 2:30 pm, monitoring of the decant pond specific conductivity was started.
- March 13 May 31 Sampling of wells and decant ponds continued.
- May 31 Tracer test terminated.

Water quality data before and after the tracer test are provided in Tables 2 and 3. Water quality data, particularly the similarity in common ion and nitrate concentrations, continue to indicate that water in the deeper gravel zones monitored by IW-1, MW-95-7, and MW-95-8 is derived primarily from mine water disposed at the decant pond. Phase 3 tracer test results suggest that the deeper gravel/sand units are not the primary groundwater flow path for decant pond water as the tracer was not detected in the wells during the monitoring period.

Based on Phase 1 and 3 results and review of the local geology, it was hypothesized that a shallow sand and gravel unit may provide the primary flow path for transport of water from the decant ponds. While the shallow sand and gravel unit is believed to transport water primarily laterally away from the decant pond, some slow transport of water downward to the deeper gravels (i.e., leakage through the silts/fine sands that underlie the shallow gravel) is believed to also occur. This leakage is believed to account for the similarity in water quality between the decant pond and the deeper wells. The slow rate of the vertical transport of water to the deeper gravels was believed to account for the lack of detection of the tracer in the deeper gravels during the 2001 tracer test.

					010100)	(Deloie Hacel lest	(100	The state of the s	The state of the s	The second second	The second second		-
	MW 95-5	MW 95-5 MW 95-4 MW 95-3	_	MW 97-12	MW-1	MW-2	MW-3	MW-4	MW-4 MW 95-7 MW 95-8	MW 95-8	IW-1	DECANT POND 1	DECANT POND 2
Alkalinity	154.	22.	89.	61.	114.	21.	113.	168.	71.	81.	75.	74.	16
Arsenic	0.008	0.004	<0.002	<0.002	900.0	<0.002	0.019	0.029	0.002	<0.002	<0.002	<0.002	<0.002
Calcium	46.	38.	130.	12.	35.	4.6	32.	30.	30.	41.	28.	31.	30
Chloride	3.9	4.2	2.7	3.0	2.1	<1.0	1.1	<1.0	<1.0	1.1	<1.0	<1.0	<1.0
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.049	0.043
Iron	36.	17.	0.22	0.20	6.9	<0.030	12.	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Hardness	171.	139.	503.	54.	111.	16.	97.	112.	92.	125.	98.	116.	113.
Bicarb.	154.	22.	89.	61.	114.	21.	113.	168.	71.	81.	75.	74.	76.
Potassium	11.	24.	74.	5.3	1.1	<1.0	<1.0	2.4	<1.0	<1.0	<1.0	<1.0	<1.0
Magnesium	13.	11.	43.	5.6	5.7	1.1	3.9	9.0	4.1	5.6	6.7	9.5	9.1
Manganese	5.8	3.0	0.99	0.10	0.55	0.14	0.59	0.24	<0.005	<0.005	<0.005	0.040	0.037
Sodium	9.0	F	53.	5.8	5.6	<1.0	5.4	23.	1.3	1.3	2.0	1.6	1.5
Ammonia	09.0	8	10.	<0.10	<0.10	0.20	0.30	0.42	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrate+nitrite	0.19		<0.10	<0.10	0.32	0.13	<0.10	<0.10	1.1	1.6	0.79	1.6	1.4
Lead	<0.002	V	ľ	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ha	8.0			6.7	8.0	6.9	7.2	8.2	8.1	8.4	8.1	8.3	8.2
Antimony	<0.005	<0>	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	0.011
Silica	58.	43.	10.	54.	25.	10.	30.	13.	12.	9.8	9.8	8.1	8.3
Sulfate	9.2	292.	693.	14.	9.6	5.3	1.4	1.2	27.	41.	25.	39.	42.
TDS	284.		1060.	150.	160.	31.	178.	197.	136.	164.	133.	171.	164.
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

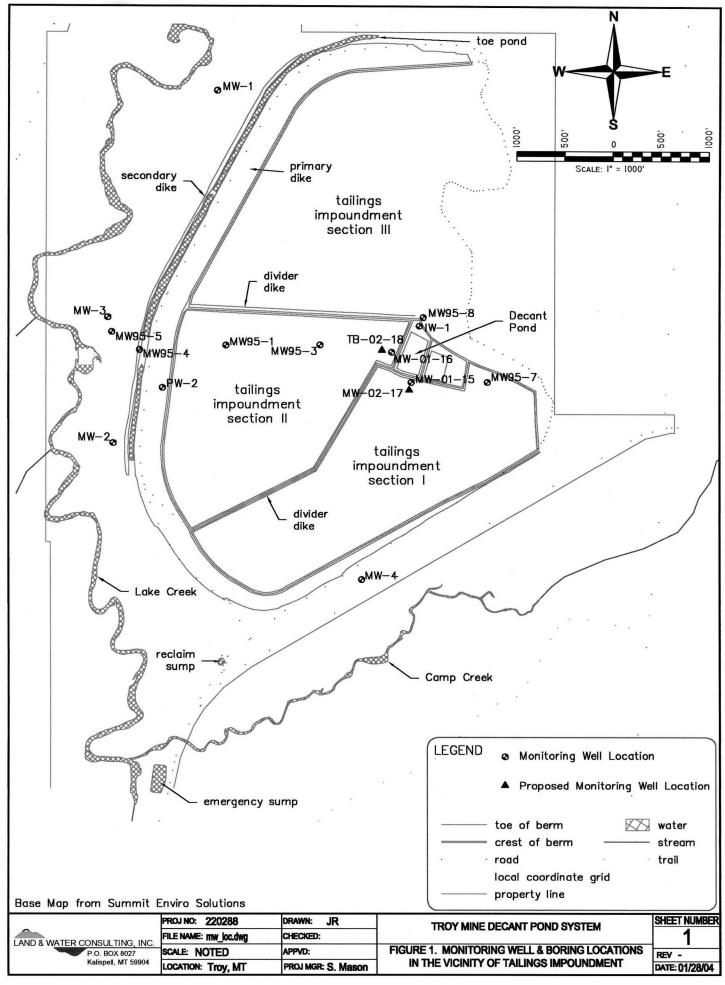
>		Table 3 April 2001 Water ( after tracer addit	Quality Data		
	DECANT POND-1	DECANT POND-2	MW-95-3	MW-95-7	IW-1
Alkalinity.	50.	76.	146.	220A	70.
Arsenic	<0.002	< 0.002	0.002	< 0.002	< 0.002
Calcium	22.	30.	130.	32.	26.
Chloride-	96.	67.	2.6	1.3	<1.0
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	0.040	0.036	< 0.002	0.002	< 0.002
Iron	< 0.050	< 0.050	< 0.050	<0.050	< 0.050
Hardness	82.	113.	502.	96.	90.
Bicarb.	50.	76.	146.	220A	70.
Potassium	1.6	1.9	79.	1.8	1.5
Magnesium	6.5	9.2	43.	4.2	6.2
Manganese	0.053	0.036	1.0	<0.005	< 0.005
Sodium	51.	38.	56.	1.5	2.8
Ammonia	<0.10	<0.10	12.	0.12	<0.10
Nitrate+nitrite	0.80	1.5	< 0.050	1.0	0.71
Lead	<0.002	< 0.002	< 0.002	< 0.002	< 0.002
рН	7.8	8.0	7.8	7.9	8.0
Antimony	0.007	0.010	< 0.005	< 0.005	< 0.005
Silica	7.0	7.3	10.	11.	13.
Sulfate	33.	40.	730.	31.	24.
TDS	243.	246.	1051.	160.	135.
Zinc	<0.010	< 0.010	< 0.010	<0.010	< 0.010

Note: All units (mg/L) except pH (std. units), alkalinity, carbonate, bicarbonate and hardness (all mg/L as CaCO3), ammonia and nitrate + nitrite (mg/L as N). All metals are dissolved. Alkalinity and bicarbonate values for MW-95-7 are suspected to be in error (cation/anion balance is significantly off).

#### 2.3 Phase 2 – Shallow Monitoring Well Installation and Sampling

Shallow monitoring wells were installed adjacent to the decant ponds to test the hypothesis that shallow sand and gravel units are the primary flow path for mine water and to monitor groundwater within shallow sand and gravel units. Results of Phase 2 work are described in the Phase 2b Work Plan (LWC, 2002).

Phase 2 began in Fall 2001 with the installation of two additional shallow monitoring wells on the south and west side of decant pond #1 (see Figure 1). These borings demonstrated that the shallow gravel unit is largely unsaturated with the exception of thin perched zones immediately adjacent to the decant ponds. Water quality monitoring indicates the groundwater in these perched zones is composed entirely or nearly entirely of mine water disposed in the decant pond. However, copper concentration in the perched zones is very low (e.g., 0.003 mg/L) indicating that attenuation of copper occurs within the decant pond or within a very short distance of the pond.



Monitoring has shown that the shallow gravel unit responds very quickly to operation of the decant pond. For instance, wells in the shallow gravel unit were dry in summer 2003 during an extended period when flows to the decant pond were shut off and the decant pond nearly dried out. When mine water flow to the decant pond was resumed, the gravel unit became saturated within a few days. The rapid response of the shallow gravel units to changes in the decant pond and the similarity in water quality between the decant pond and the groundwater in the shallow gravel unit suggest that the shallow gravel units are the primary groundwater flow path for mine water disposed in the decant pond.

#### 2.4 Phase 2b – Deep Boring

Installation of the additional shallow monitoring wells in 2001 completed an operational monitoring system for the shallow gravel unit. To further characterize groundwater within the deeper gravel units an additional deep boring (TB-02-18) was advanced on the west side of the decant pond in 2002 (see Figure 1) with the intent to complete the boring as a monitoring well.

Conditions encountered in the deep boring confirm the presence of a saturated gravel unit at intermediate depth (approximately 89 to 121 feet bgs) near the west side of decant pond. This gravel unit is overlain by very fine silt and sand tailings. The deep gravel unit was not found on the west side of the decant pond as relatively impermeable silts and clays were found to underlie the gravel unit to depths of at least 280 feet bgs. The lack of the deep gravel on the west side of the decant pond suggests that the deep gravel unit is not laterally extensive. Most likely, the deep gravel unit is merely one, of likely many, gravel outwash layers interbedded within the lake silts and till that form the bulk of the sedimentary deposits in the area. Information from deep boring supports the view that the shallow gravel units comprise the primary flow path for mine water disposed in the decant pond.

The deep boring was cased with open-ended steel casing during drilling to allow the potential completion of the boring as a monitoring well. Unfortunately the boring is not appropriate for use as a monitoring well due to heaving of silt within the well bore and extremely low water yield. After drilling to a total depth of 281 feet bgs, water level in the well rose to approximately 100 feet bgs. The boring was then pumped to further develop and purge the well and to determine well yield. Upon pumping, the sediments surrounding the boring heaved and filled the boring with silt to a depth of approximately 200 feet bgs. The well was found to yield less than 0.5 gallons per minute (gpm) and was pumped dry very quickly. Repeated pumping of the well was conducted in an attempt to develop the well but the boring was continually filled with heaving sediments and the well yield did not improve. If the well is to be completed as a monitoring well it is recommended that the well be completed to monitor the gravel unit at approximately 90 to 120 feet bgs (i.e., the boring could be plugged and/or packed at a depth of 120 feet and perforated from approximately 90 to 110 feet bgs).

#### 3.0 PHASE 4 – GEOCHEMICAL TESTING OF AQUIFER MATERIALS

Geochemical testing of aquifer materials was conducted in 2003 and generally followed the proposed Study Plan:

"The types of testing of tailings and materials to be conducted will depend on whether the mine water flow paths can be identified and samples of aquifer materials can be obtained. If the mine water flow paths can be located, then testing will focus on analysis of aquifer materials (may include tailings if tailings are found to be the flow path) to determine the mechanisms and phases that are responsible for copper attenuation as well as the capacity of materials for attenuation. Testing of aquifer materials from the mine water flow path would consist of:

- 1. Total metal analysis.
- 2. Sequential extraction analysis (Gatehouse et al 1977, Hydrometrics, 1986) to identify the phases that are enriched in copper. This analysis determines the trace metal contents of six phases: water soluble, exchangeable and carbonate, manganese oxides, organic matter, amorphous iron oxides, silicates and crystalline oxides.
- 3. Optional batch attenuation capacity testing to develop adsorption isotherms. This testing would be done if adsorption is found to be the dominant control on copper mobility (e.g., exchangeable phases are enriched in copper). Testing methods would follow those described by EPA (1987).
- 4. Optional electron microprobe analysis to determine mineral phases enriched in copper. This testing would be done if mineral precipitation is found to be the dominant control on copper mobility (e.g. oxide phases enriched in copper)." (Hydrometrics, 2000).

#### 3.1 Collection and Description of Decant Pond Soil/Sediment Samples

Early phases of the evaluation demonstrated that although the mine water flow path had been identified as the shallow gravel zones, copper attenuation occurred sufficiently close to the decant pond that even monitoring wells completed within 30 to 50 feet of the pond (i.e., wells MW-01-15 and MW-01-16) were outside of the primary attenuation zone. Thus, aquifer materials collected from the monitoring wells would not be expected to be strongly enriched in copper and could not be analyzed to determine the attenuation mechanisms. Instead, soil/sediment samples were collected from shallow pits dug in the bottom of the decant pond.

The summer of 2003 presented a rare opportunity to access the bottom of the decant pond. Due to prolonged drought conditions and cessation of discharge of mine water to the pond for several months the decant pond became nearly dry during April 2003. On April 11, 2003, sediment samples from the decant pond were collected from shallow test pits/holes dug by shovel and/or soil auger. Participating in sample collection were Scott Mason (LWC), George Furniss (MDEQ) and Bruce Clark (Genesis). Photographs of sediment samples and decant pond conditions are presented in Appendix A. The following soil descriptions and sequence

of layers are typical of the pond. However, thickness of the following layers are variable across the pond.

#### Surface Soil/Sediment

Brown, fine silt and sand (tailings), abundant algal mats, some vegetation (sticks, pine needles, leaves). Underside of vegetation shows black organic staining and green staining from algae (?) or possibly copper (?) (see Photos 2 and 3, Appendix A). Sample submitted for analysis: DP-1 algae.

#### 0 to 2 inches (or thicker)

Alternating thin (0.5 to 2 mm) laminations of fine silt and sand (tailings) (see Photos 4 through 7, Appendix A). Colors range from buff (primarily in silt tails or "slimes" layers), to rust brown red to green (primarily in sand), to black in areas with organic materials (around buried leaves, pine needles, sticks, algae).

Buff colored layers appear under hand lens to be primarily fine silt-sized quartz grains with occasional sulfides – pyrite and possibly chalcopyrite. Very slight to absent iron oxidation and associated staining. These layers likely represent tailings without strong enrichment by secondary copper minerals.

Rust brown red layers appear under hand lens to be primarily quartz grains with slight to heavy staining. Initially, staining was thought to be iron oxide/hydroxide but based on electron microprobe analyses (see Section 3.3) it is possible or even likely that staining is copper manganese silicates/copper iron silicates.

Green layers appear under hand lens to be primarily quartz grains with slight to moderate brown staining and containing green grains of copper oxide/carbonate (note bright green staining in center of Photos 5 and 6, Appendix A). Although brown and green layers are alternating (in some areas 10 or more layers to the inch), it appears that in most cases brown layers are above adjacent green layers.

Black areas occur within the buff, brown, and green layers and are associated with organic material (see Photo 4 and the black spot in the center of Photo 7, Appendix A).

Samples submitted for analysis: DP-1 0-1 ", DP-1 3 3/4", DP-1 4", DP-1 4" organic.

#### 2 to 4 inches

Buff-colored, very fine grained "slime" tailings. Sample analyzed: DP-1 2-4" slime tails.

#### 4 to 8" inches

Buff-colored, fine sand tailings. Some iron oxide grains, minimal to absent staining. Sample analyzed: DP-1 4-8" sand tails.

#### 1 to 4 foot wet sand tails

White to gray, fine sand tailings (see Photo 8, Appendix A). Some unidentifiable black grains. No signs of iron oxidation. Sample analyzed: DP-1 1-4' sand tails.

#### Native sand from pond embankment below water level

Brown, medium to coarse-grained sand and gravel. Sample analyzed: DP-1 native sand.

#### 3.2 Soil Total Metal Analyses

As the first step in soil geochemical characterization the soil samples were submitted to the American Environmental Consultants Laboratory in Salt Lake City for analyses for total copper and iron. The samples were over dried, sieved, ground and digested (HF digestion) and analyzed by ICP spectroscopy. The purposes for this testing were:

- 1. To determine if soil is enriched in copper. Enrichment in copper would be partial evidence for attenuation of copper by the soils and would justify further testing of soils.
- 2. To evaluate potential relationships between copper enrichment and iron and organic matter content.

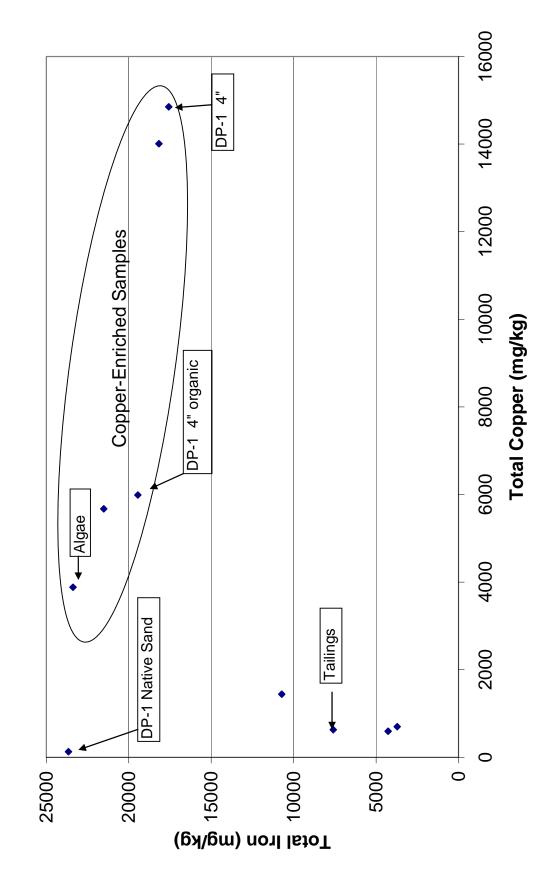
Results of the total metal analyses are summarized in Table 4 and Figure 2 along with metal concentrations found in Troy Mine tailings and ore and native soil from tailing impoundment area. As described in Section 3.1, most of the decant pond soil/sediments are composed of tailings. Comparison of copper concentration in decant pond sediment with copper concentrations in Troy tailings and native soils indicates that all of the soil/sediment samples collected at depths of less than four inches are strongly enriched in copper relative to native soils and tailings. Some soil/sediment samples (DP-1 3 ¾ " and DP-1 4") are enriched to the extent that they contain nearly twice the copper content as ore from the Troy mine. Total copper concentrations in decant pond sediments suggest that copper is attenuated in surficial soil/sediments in the decant pond.

Two organic-rich samples (DP-1 algae and DP-1 4" organic) were specifically selected to evaluate whether the presence of abundant organic matter in soil/sediment enhances attenuation of copper by the soils. Both of the organic-rich samples were enriched in copper relative to native soil and tailings, however, they do not appear to be more strongly enriched than samples with lesser organic matter contents. In particular, sample DP-1 4", collected adjacent to DP-1 4" organic but not containing abundant organic matter, was found to contain much more copper than DP-1 4" organic. As shown in Figure 2, there appears to be a slight negative correlation between iron and copper concentrations in copper-enriched samples.

Total Copper a	Table 4 Total Copper and Iron Content of Decant Pond Soil Samples						
Sample Designation	Total Copper (mg/kg or ppm)	Total Iron (mg/kg or ppm)					
DP-1 algae	3,881	23,380					
DP-1 0-1 ",	5,672	21,520					
DP-1 3 ¾",	14,010	18,170					
DP-1 4",	14,850	17,580					
DP-1 4" organic	5,987	19,450					
DP-1 2-4" slime tails	1,441	10,720					
DP-1 4-8" sand tails	698	3,724					
DP-1 1-4' sand tails	594	4,269					
DP-1 native sand	127	23,660					
Troy tailings (1)	630	7,600					
Troy ore (2)	7,600						
Native soil (3)	10 to 30						

- (1) Data source: Table 4-23, Rock Creek Final EIS, September 2001.
- (2) Data source: Table 3-2, Rock Creek Final EIS, September 2001.
  (3) Data source: Appendix D, Troy Unit Revised Reclamation Plan, (Hydrometrics et al, December 2000).

Figure 2. Total Copper and Iron Content in Decant Pond Soils



#### 3.3 Mineralogical Characterization of Soil/Sediment Samples

Mineralogical characterization of soil/sediment samples was proposed as an optional assessment in the Study Plan. Because of the visually apparent presence of secondary copper mineral grains and grain coatings in soil/sediment samples, mineralogical analyses were conducted as part of the assessment. The goal of mineral characterization was to determine the identity and composition of copper phases in the soil/sediment.

Initially, x-ray diffraction analysis of samples was attempted at the American Environmental Consultants Laboratory in Salt Lake City. X-ray diffraction analysis can be used to identify crystalline minerals that are present in sufficient quantities to yield discernible diffraction patterns. No diffraction patterns for known copper minerals could be identified in the diffraction patterns obtained from the decant pond samples. The lack of diffraction patterns was most likely due to poorly crystallized or amorphous copper phases and low abundance of copper minerals relative to other minerals present.

Electron microprobe analysis of the samples was somewhat difficult but ultimately successful in identifying the chemical compositions of the copper phases in the decant pond soil/sediment samples. Additional soil samples for microprobe analysis were collected on April 11, 2003 and are described as follows:

- Sample DP-1; ½" depth, brown, apparently iron-stained soil that may contain some amount of native sand. Sample appeared under hand lens to be primarily quartz grains with slight to heavy brown staining.
- Sample DP-1; 3" depth, green, soil/sediment that is primarily tailings. Sample appeared under hand lens to be primarily quartz grains with slight to moderate oxide staining, some green grains of copper (?) are discernible.

Photographs of pond conditions and soil samples at the time of sample collection are provided in Appendix B. During June the pond had virtually dried up and access to nearly the entire pond bottom was attained. Reconnaissance of the pond bottom in June verified that the abundant copper mineralization and layering in pond soils/sediment observed in April is ubiquitous and extends across the entire pond.

Microprobe analyses were conducted by Cannon Microprobe in Seattle. Polished thick sections were prepared from plus fifteen micron sieve fractions and from raw fracture surfaces parallel to green laminations in the samples. Sample preparation proved to be the most difficult aspect of the analyses as the visually-apparent green mineral grains that were thought to be copper oxides or carbonates were found to be very soft and easily destroyed by routine sample preparation methods.

All sample types were analyzed using back-scattered electron imaging at magnifications between 200x and 1500x. In this mode, mineral grains of higher atomic number (generally metals) appear as brighter features on the microscope video monitor and can be targeted for analysis. Chemical compositions of mineral grains were identified by wavelength and energy

dispersive x-ray spectrometers. Estimates of mineral identities of copper phases were made based on knowledge of chemical composition of mineral phases combined with visual appearance in the stereomicroscope and scanning electron microscope. Mineral identification by this method is not completely definitive, especially for uncommon minerals, oxides, and carbonates because the microprobe cannot discriminate phases based on crystal structure and cannot identify lighter elements such as oxygen and carbon. Results of the microprobe analyses including photomicrographs and x-ray spectra are included in Appendix C.

Copper phases identified in the samples include:

- Copper silicates (likely the blue-green mineral chrysocolla);
- Copper carbonates (likely the green mineral malachite);
- Copper manganese silicates;
- Copper iron oxides; and
- Copper iron sulfides (likely chalcopyrite and bornite).

#### 3.4 Sequential Extraction Analysis of Soil/Sediment Samples

Soil/sediment samples were analyzed by sequential extraction analyses according to the method of Gatehouse et. al. (1977). The purpose of these analyses was to supplement results of the microprobe analysis in two ways:

- 1. Provide a quantitative or semi-quantitative estimate of which copper-bearing phases are most important in copper attenuation (i.e., which phases contain most of the copper).
- 2. Provide an indication of the importance of organic matter in copper attenuation, since the microprobe cannot analyze carbon or organic matter.

Sequential extraction analysis is based on the fact that different materials or mineral phases differ in their ability to be dissolved by different chemical mixtures or reagents. The extraction steps and the phases targeted for removal by each step are summarized in Table 5. Sequential extraction analyses were conducted at the American Environmental Consultants Laboratory in Salt Lake City.

S	Table 5 Sequential Extraction Steps and T	Γarget Phases
<b>Extraction Step</b>	Extraction Fluid	Phase Removed
1	Water	Water Soluble
2	Ammonium acetate	Exchangeable Ions and Carbonates
3	Hydroxylamine hydrochloride	Manganese and Copper Oxides
4	Hydrogen peroxide	Organic Matter and Sulfides
5	Hydrazine chloride	Amorphous Iron Oxide
6	Strong Acids:	Silicates and Resistant Phases
	Nitric/Perchloric/Hydrofluoric	

Results of the sequential extraction analyses are presented in Table 6 and Figures 3 and 4. Sequential extraction results indicate that the dominant copper-bearing phases in the decant pond soils are: exchangeable ions and carbonates, organic matter and sulfides, and silicates.

	Table 6 Sequential Extraction Results							
Sample	Water Soluble	Exchangeable Ions and Carbonates	Manganese and Copper Oxides	Organic Matter and Sulfides	Amorphous Iron Oxide	Silicates and Resistant Phases	Total Copper (sum all phases)	
	Mass of Copper in Each Phase (mg/kg or ppm)							
DP-1 0-1 ",	27	3357	619	964	350	484	5801	
DP-1 3 ¾",	10	5814	487	4084	12	3587	13994	
DP-1 4"	17	5255	432	5267	4.5	3722	14697	
DP-1 4" org	28	1419	63	3162	5.5	1205	5882	
			Percen	t Copper in l	Each Phase			
DP-1 0-1 ",	0.47	57.87	10.67	16.62	6.03	8.34		
DP-1 3 ¾",	0.07	41.55	3.48	29.18	0.09	25.63		
DP-1 4"	0.12	35.75	2.94	35.84	0.03	25.32		
DP-1 4" org	0.48	24.12	1.07	53.75	0.09	20.48		

Silicates and Resistant Phases Amorphous Iron Organic Matter & Sulfides Exchangeable lons & Manganese & Copper Carbonate Oxides Water Soluble 40 35 0 45 30 25 20 9 2 Percent of Total Copper Present

Figure 3. Average Copper Fractionation in Decant Pond Soils

■ DP-1 4" organic ■ DP-1 0-1 ", □ DP-1 3 ¾", □ DP-1 4", Silicates and Resistant Phases Amorphous Iron Organic Matter & Sulfides Manganese & Copper Oxides Exchangeable lons & Carbonate Water Soluble 0.00 70.00 00.09 50.00 10.00 40.00 30.00 20.00 Percent of Total Copper

Figure 4. Copper Fractionation in Decant Pond Soils

## 4.0 HYDROGEOLOGY AND GROUNDWATER TRANSPORT OF MINE WATER

As described in the preceding sections, all data collected to date indicates that mine water is transported within permeable sand and gravel zones near the decant pond. Based on the mode by which these sand and gravel zones were deposited and based on numerous borings and wells constructed in the area, these zones do not appear to be laterally extensive. The following sections summarize the local and regional geology and hydrogeology.

#### 4.1 Regional Geology and Hydrogeology

The following description of regional geology and hydrogeology is based on the summary by Montana Bureau of Mines and Geology (MBMG) and US Geological Survey (USGS) in Levings et. al. (1984). Lake Creek Valley is a graben that has been modified by glacial and stream erosion. During pre-Wisconsin glaciation a tongue of the Cordilleran ice sheet moved southward up Lake Creek Valley and extended about 10 miles down the valley of the Bull River. Additional ice came from tributary glaciers emerging from mountains to the east and west of the valley. During Wisconsin glaciation, the ice sheet moved southward again terminating south of Bull Lake. As these ice sheets retreated, glacial lakes were formed by melting glaciers.

Lake Creek Valley is filled with unconsolidated to semi-consolidated deposits of silt, clay and sand interbedded with gravel and cobble zones. The fine-grained silt and clay are glaciolacustrine deposits formed within the glacial lakes. The gravel and cobble zones are discontinuous, of relatively small areal extent, and generally cannot be traced in the subsurface more than a few hundred feet. These gravel and cobble deposits were laid down by streams flowing from the mountains into glacial meltwater lakes as the glacier receded northward.

Holocene alluvial deposits of sand and gravel occur along Lake Creek and major tributaries. No data exist on the maximum thickness of these deposits, but it is probably only a few tens of feet.

Groundwater in the Lake Creek Valley occurs primarily in the sand, gravel and cobble zones of the glaciolacustrine deposits. The silt and clay zones generally are confining beds that restrict vertical groundwater movement. Groundwater movement in Lake Creek Valley is presumed to be from the valley sides toward Lake Creek and to the north.

### 4.2 Geology and Hydrogeology of Decant Pond Area

Information on the hydrogeology of the decant pond area has been obtained through several drilling/boring campaigns including:

- 1. Geotechnical borings investigations (see Woodward-Clyde, 1977);
- 2. Monitoring well installation by Summit and MF&G, (1996);
- 3. Shallow monitoring well installation by Hydrometrics (2001); and
- 4. Deep test boring by LWC (see Section 2.4).

The local geology and hydrogeology matches closely the regional geology/hydrogeology as described by MBMB and USGS personnel. Materials underlying and surrounding the decant pond is comprised of unconsolidated deposits of silt, clay and sand interbedded with gravel and cobble zones. The fine-grained silt and clay are glaciolacustrine deposits formed within the glacial lakes. The gravel and cobble zones are discontinuous, of relatively small areal extent, and generally cannot be traced in the subsurface more than a few hundred feet. The primary occurrence of groundwater and the primary flow path for mine water disposed in the decant pond is in the gravel zones. Locations and depths of identified gravel zones in the impoundment area are summarized in Table 7.

	Table 7 Identified Permeable Zones in the Vicinity of the Decant Ponds						
Well/Borin g	Location	Zone Description	Other				
MW-01-15	Approx. 30 feet south of decant pond #1.	Gravel and sand 12 to 23 and 25 to 34 ft bgs.	Well screened 30 to 40 ft bgs.				
MW-01-16	Approx. 30 feet west of decant pond #1.	Sand with gravel 31 to 40 ft bgs.	Well screened 32 to 42 ft bgs.				
TB-02-18	Approx. 50 feet west of decant pond #1.	Coarse sand and gravel 89 to 121 ft bgs.	Open-hole at 281 ft bgs.; insufficient water to sample.				
MW-95-7	Approx. 250 feet east southeast of decant pond #3	Gravel 0 to 18 ft bgs;	Well screened 79 to 89 ft bgs.				
MW-95-8	Approx. 50 feet north of decant pond #1, north side of Section 2/3 divider dike.	Gravel, cobbles, sand 0 to 20 ft bgs;	Well screened 48 to 53 ft bgs.				
IW-1	Approx. 20 feet north of decant pond #1.	No drilling logs can be found, Asarco internal memos refer to well as screened in "lower sand and gravel aquifer".	Well screened 190 to 210 ft bgs.				
MW-1	Approx. 4,000' northwest of decant ponds between dike and Lake Creek	Clean sand and gravel 160 to 280 bgs	Well perforated 55 to 100 ft bgs in silt/clay and 160 to 280 ft bgs				
MW-3	Approx. 3,000' west of decant ponds between dike and Lake Creek.	Sand and gravel 118 to 125' bgs	Open-ended casing				
TH-10	Section 2 approx. 1,000' west of decant ponds	Very gravelly sand 8 to 40' bgs	Field permeability 4,400 ft/yr				
TH-11	In section 1 approx. 800' south of decant ponds	Gravel 0 to 40' bgs	Field permeability 8,100 ft/yr				
TH-12  *bgs = below g	Southeast portion section 2; approx. 1200 feet southwest decant ponds	Gravelly sand to gravel 5 to 40'bgs	Field permeability 1,100 ft/yr				

#### 5.0 FATE OF COPPER IN DECANT POND AND GROUNDWATER

As described in the preceding sections, all data collected to date indicates that copper is very immobile in the groundwater system surrounding the decant pond. Copper in mine water that is disposed in the decant pond becomes primarily bound in shallow soils/sediment in the bottom of the decant pond and very little copper is transported beyond a few tens or hundreds of feet in the groundwater system. The following sections discuss the mechanisms and controls of copper removal (attenuation) processes and a general conceptual model of the fate of copper in the decant pond/groundwater system.

#### **5.1** Mechanisms of Copper Attenuation

Visual observation and geochemical testing of soils and sediments from the bottom of the decant pond demonstrate that copper dissolved in mine water and disposed in the decant pond is removed and concentrated in:

- Secondary copper minerals including copper carbonate (malachite), copper silicate (chrysocolla), copper oxides and copper iron oxides, and copper iron/copper manganese silicates formed in decant pond soils/sediments.
- Organic material including algae and decomposing detritus such as pine needles in the decant pond sediments.

Based on the presence of these copper phases, the mechanisms of copper attenuation are determined to be precipitation (formation) of secondary copper minerals and adsorption of copper by organic matter.

#### 5.2 Controls of Copper Solubility and Attenuation

The primary controls of copper attenuation mechanisms appear to be:

- Changes in mine water chemistry (redox conditions, alkalinity, dissolved silica) between the underground mine and the surficial decant pond that result in precipitation of copper minerals in the decant pond sediments; and
- The presence of organic matter with high copper-adsorptive capacity in the decant pond sediments.

Copper is present in the waste rock and ore in the underground mine openings in the form of copper sulfides (chalcocite and digenite) and copper iron sulfides (chalcopyrite) (Rock Creek EIS; MDEQ and USFS, 2001). The presence of copper in mine water is due to the dissolution of the copper sulfide minerals by oxidation reactions such as:

Subsequently, secondary copper minerals such as malachite and chrysocolla are formed or precipitated from dissolved copper ions when the geochemical conditions are appropriate. Secondary minerals are formed by reactions such as:

These reactions indicate that formation of secondary minerals and attenuation of copper is favored by conditions of relatively higher carbonate/bicarbonate (inorganic carbon) concentrations, higher dissolved silica concentrations, and higher dissolved oxygen concentrations (or higher pe or redox conditions). This conclusion is supported by correlations between mine water chemistry and copper concentrations and by the occurrence of these secondary minerals in soils/sediments at the decant pond.

#### 5.2.1 Redox Controls

Water samples of underground mine water at various locations (UQ-1, adit pipe, adit ditch, south ore body reservoir, and transfer point), decant pond water, and groundwater in monitoring well MW-15 adjacent to the decant pond were collected and analyzed in April and May 2003. Laboratory reports for these samples are included as Appendix D. Redox conditions in these water samples were calculated in two ways: 1) based on dissolved manganese concentrations assuming equilibrium with manganese oxide; and 2) based on ammonia and nitrate concentrations assuming equilibrium between the redox pair. Figure 5 shows a comparison between pe values calculated from the different redox pairs. In general, the correlation between the two methods is good, although values calculated based on the nitrogen pair are lower.

Comparison between calculated pe values and dissolved copper concentrations in the water samples is also relatively good as shown in Figure 6. In general, moderately oxidizing conditions (lower pe) such as occur in the underground workings are conducive to higher copper concentrations while more oxidizing conditions (higher pe) are conducive to lower copper concentrations, most likely as the result of the formation of copper oxide minerals/phases. During infiltration/percolation of rainfall and groundwater to the mine workings the amount of oxygen in mine water is reduced, first by soil biological activity and later by reaction with sulfide minerals present in the ore and waste rock. Disposal of mine water in the decant pond subsequently results in exposure of the water to abundant atmospheric oxygen which raises the pe or redox condition of the water and results in the formation of oxide minerals.

Figure 5. Comparison of pe Calculated from Manganese and Nitrogen Concentrations in Mine Water and Groundwater

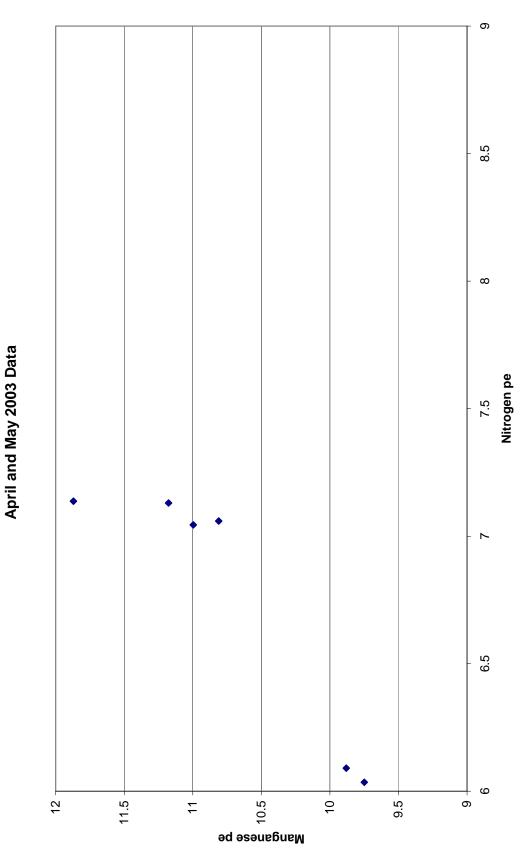
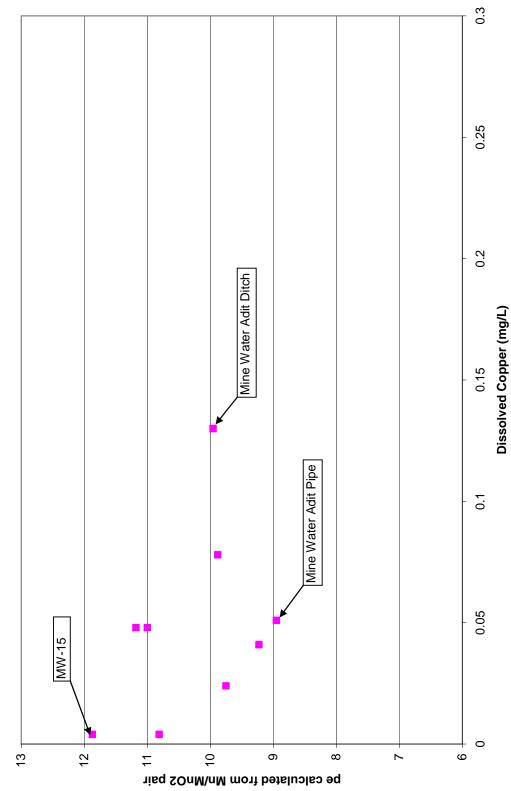


Figure 6. Dissolved Copper vs pe in Mine Water and Groundwater April and May 2003 Data



#### 5.2.2 Dissolved Silica Concentrations

Figure 7 presents the correlation between dissolved silica and dissolved copper concentrations in mine water and groundwater. In general, higher silica concentrations correspond to lower copper concentrations. This correlation is consistent with control of copper concentrations by formation of copper silicate (chrysocolla). Blue-green chrysocolla has been identified in soils and sediments in the decant pond both visually and by microprobe. The reason for the increase in dissolved silica in the groundwater system near the decant pond is not known with certainty, but may be due to the abundant quantity of finely ground silica (quartz) that makes up the bulk of the tailings material and is also abundant in soils and sediments in the decant pond.

#### 5.2.3 Inorganic Carbon (Bicarbonate/Carbonate) Concentrations

Copper carbonate (malachite) has been identified visually and by microprobe in soils and sediments in the decant pond. The presence of copper carbonate implies an increase in dissolved inorganic carbon in decant pond sediments (e.g., see malachite precipitation reaction above, addition of inorganic carbon (bicarbonate) drives the reaction toward malachite formation). Although dissolved inorganic carbon has not been measured in mine water or groundwater, empirical evidence for partial control of copper concentrations by carbonate comes from water treatment bench-scale testing results. To test potential water treatment methods, limestone (calcium carbonate) was added to mine water in a beaker and allowed to sit for twelve hours. During this period the mine water dissolved approximately 75 mg/L of calcium carbonate and as a result of this treatment, copper concentration of the water was reduced by approximately 55 percent (Troy Unit Revised Reclamation Plan, Hydrometrics et. al., 2000). One possible source for inorganic carbon in the decant pond soils/sediments is finely ground calcium carbonate present in the tailings. An additional source is the decomposition of organic carbon (e.g., algae and plant matter) to inorganic carbon (e.g., carbon dioxide) by microbiological activity in the soils. Because there is essentially no organic carbon in mine water in the underground workings, biological activity could increase the inorganic carbon content in water in decant pond soils/sediments.

#### 5.2.4 Adsorption by Organic Carbon

Organic matter such as algae and plant detritus has a strong affinity for adsorption of copper (Breault et. al., 1996; Temminghoff et. al., 1997; Levy et. al., 1992). During collection of soil samples, the occurrence of organic material (primarily algae, leaves, and pine needles) within the soil profile was noted. Black areas and layers of decomposed organic matter also occur within the buff, brown, and green soils layers. It is likely that a portion of the copper attenuation is attributable to adsorption by organic carbon. This conclusion is also supported by sequential extraction testing which indicates copper is bound in organic carbon/sulfide phases.

♦ sio2 0.14 0.12 0.1 April and May 2003 Data 0.08 Mine Water Adit Pipe Copper (mg/L) 0.04 -MW-15 0.02 70 10 4 9 Ż ∞ Silica (mg/L)

Figure 7. Copper versus Silica in Mine Water and Groundwater

#### 5.3 Conceptual Model of Copper Fate in Decant Pond/Groundwater System

Copper is initially solubilized by the oxidation of copper sulfide ore minerals in and around the underground mine workings. A portion of the dissolved copper is precipitated and forms solid copper oxides, copper carbonates, and copper silicates minerals within the underground workings. These secondary copper minerals are apparent as green and blue stains present in some locations in the mine, commonly where water drips from cracks, drill holes, or roof bolts in the mine back (ceiling) and evaporates on walls and floors. The formation of these secondary copper minerals in the mine is likely limited by the availability (concentration) of dissolved oxygen, silica, and inorganic carbon in mine water. Lack of sunlight and organic carbon in the mine also limits the formation of these secondary minerals.

A variety of subtle, but important, chemical changes occur in mine water after it is disposed in the decant pond and infiltrates soil/sediments beneath the pond. These changes include:

- 1. Increased availability of dissolved oxygen;
- 2. Increased availability of dissolved silica; and
- 3. Increased availability of inorganic and organic carbon.

These chemical changes cause the precipitation of secondary copper minerals including copper oxide, copper carbonate (malachite), and copper silicate (chrysocolla) from the mine water and a reduction of the concentration of copper dissolved in the water to levels similar to ambient groundwater. The overall fate of copper in mine water disposed in the decant pond is immobilization in shallow soils within a few feet of the decant pond. Copper in mine water disposed in the decant pond is not transported any significant distance from the decant pond.

#### 6.0 CONCLUSIONS

Groundwater and surface water monitoring demonstrates that mine water has been disposed in the decant pond since 1993 with little or no apparent effect on ambient water quality. Continued discharge of mine water to the decant pond has been considered as a potential long-term method of mine water disposal. In order for impoundment discharge to be considered further, both the physical flow paths and the transport and attenuation mechanisms for copper in the impoundment/groundwater system have been further assessed. Flow paths have been identified so that an effective groundwater monitoring system can be installed. Transport and attenuation mechanisms have been assessed to determine the long-term fate of constituents in mine water and the effects of long-term discharge on ambient groundwater and stream quality.

Investigations conducted during 2000 through 2003 to characterize the fate and transport of copper in mine water disposed in the decant pond at the Troy Mine tailings impoundment include:

- Phase 1 Groundwater Sampling and Water Quality Evaluation
- Phase 2 Monitoring Well Installation
- Phase 2b Deep Monitoring Well Installation
- Phase 3 Groundwater Tracer Testing
- Phase 4 Geochemical Evaluation

#### Results of these studies demonstrate that:

- 1. Groundwater transport of mine water occurs primarily in permeable sand and gravel zones beneath the decant ponds;
- 2. Copper concentrations are quickly attenuated (reduced) to levels below human health and aquatic life standards during groundwater transport within a short distance (ten to one hundred feet) of the decant ponds;
- 3. The mechanisms responsible for copper attenuation include formation of copper minerals and adsorption by organic matter in soils and sediment beneath the decant pond. These mechanisms are expected to continue such that further migration of copper in groundwater is not expected; and
- 4. Because of the limited transport of copper in groundwater, no impacts to ambient groundwater and surface water in the area is expected to occur from continued disposal of mine water in the decant pond.

Based on these findings, the decant ponds appear to constitute an effective, long-term mine water treatment and disposal system.

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## Appendix A

# PHOTOGRAPHS OF SOILS AND SEDIMENTS IN DECANT POND APRIL 11, 2003

Assessment of Fate and Transport of Copper in Decant Pond Disposal System – Troy Mine Lincoln County, Montana



**Photograph No. 1:** Decant Pond #1 looking south.



**Photograph No. 2:** Decant pond surface soil showing staining beneath stick. Quarter for scale.



**Photograph No. 3:** Close-up beneath stick.



**Photograph No. 4:** Layering in soils and black staining associated with decaying organic matter.



**Photograph No. 5:** Green and brown layering. Note bright green copper mineralization along fracture in center of photo.



**Photograph No. 6:** Green copper mineralization in soils.



**Photograph No. 7:** Example of green and brown mineralization due to formation of secondary copper minerals.



**Photograph No. 8:** View of deep (approx. 4 feet) boring. Note that mineralization (staining) is weak below surficial layers.

### Appendix B

# PHOTOGRAPHS OF SOILS AND SEDIMENTS IN DECANT POND JUNE 19, 2003

Assessment of Fate and Transport of Copper in Decant Pond Disposal System – Troy Mine Lincoln County, Montana



Photograph No. 1: Decant pond looking southwest.



Photograph No. 2: Decant pond looking southwest.



Photograph No. 3: Brown and green layering of copper mineralization in surface soil.



Photograph No. 4: Brown and green layering of copper mineralization in surface soil.



Photograph No. 5: Brown and green layering of copper mineralization in surface soil.



Photograph No. 6: Close-up of green copper-bearing layer.

### **Appendix C**

### **ELECTRON MICROPROBE ANALYSIS REPORT**

Assessment of Fate and Transport of Copper in Decant Pond Disposal System – Troy Mine Lincoln County, Montana

# Cannon Microprobe



#### ELECTRON MICROPROBE and SCANNING ELECTRON MICROSCOPE ANALYSIS of DP-1 DECANT POND SEDIMENTS

Scott Mason Land and Water Consulting, Inc. 221 Parkway Drive Box 8027 Kalispell, Montana 59904

November 25, 2003 Invoice 2003 - 171

#### **Descriptions of Samples**

2 samples of wet, fine silts in glass jars.

#### Purpose of Analysis

Determine heavy metal bearing mineralogy with emphasis upon copper mineralogy.

#### **Sample Preparation**

Polished thick sections were prepared from the plus 15 micron size fraction. Several raw fracture surfaces parallel to pale green laminations were prepared.

#### Operating Conditions and Instruments

ARL SEMQ electron Microprobe with six wavelength dispersive x-ray spectrometers and energy dispersive x-ray spectrometer and television rate backscattered electron detector operated at 20 KV and 50 nA beam current.

#### Method of Analysis

All sample types were analyzed using back scattered electron imaging at magnifications between 200X and 1500X. In this imaging mode, mineral grains of higher atomic number appear as brighter features on the microscope video monitor.

#### Analyst

Bart Cannon

#### RESULTS

#### DP-1 0.5"

The most important mode of occurrence of copper in the sample is as a dark brown copper manganese silicate. This copper manganese silicate may be the rare mineral abswurmbachite, but I feel it is more likely to be a manganese rich form of the secondary iron silicate hisingerite.

Blue green to green copper silicates and copper carbonates such as chyrsocolla and malachite are present and more visually apparent than the copper manganese silicates when the samples are observed using the stereomicroscope, but are, in fact less abundant than the copper

manganese silicate and bornite, chalcopyrite and delafossite which were also encountered when analyzed using the electron microprobe's back scattered electron microscope imaging function.

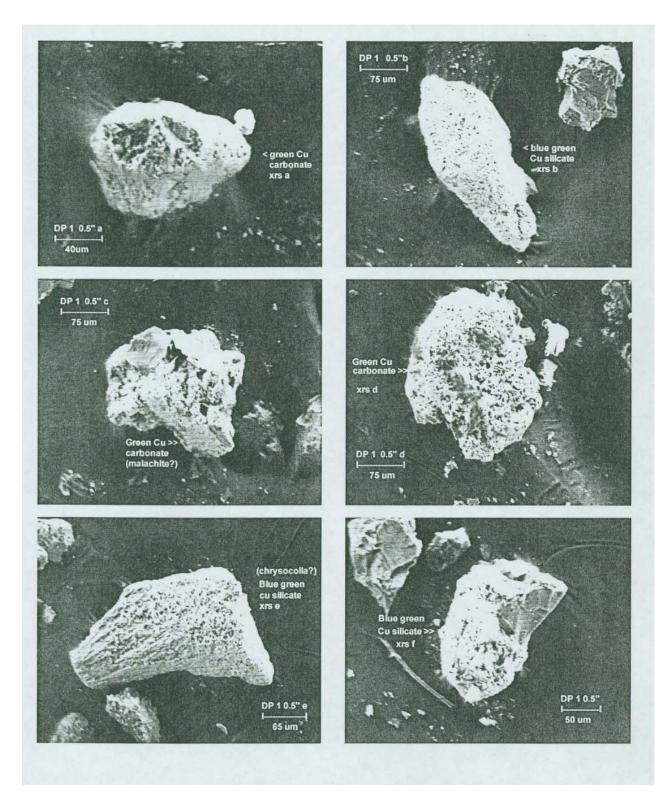
Several samples were made from clasts of the samples DP-1 @ 0.5" and DP-1 @ 3.0". The clasts were "cleaved" parallel to faint greenish laminations which were susupected to be copper rich. Discrete copper bearing grains could not be isolated, but copper was detected and an x-ray spectrum obtained from a long scan across a green layer is shown in x-ray spectrum "u".

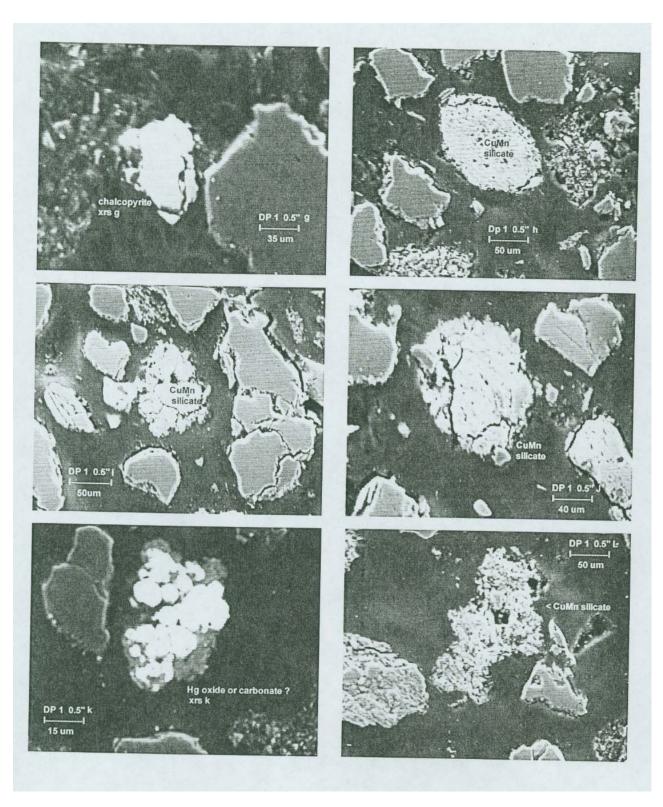
Photo "k" shows an aggregate of a crystallized mercury compound. It may be the oxide montroydite.

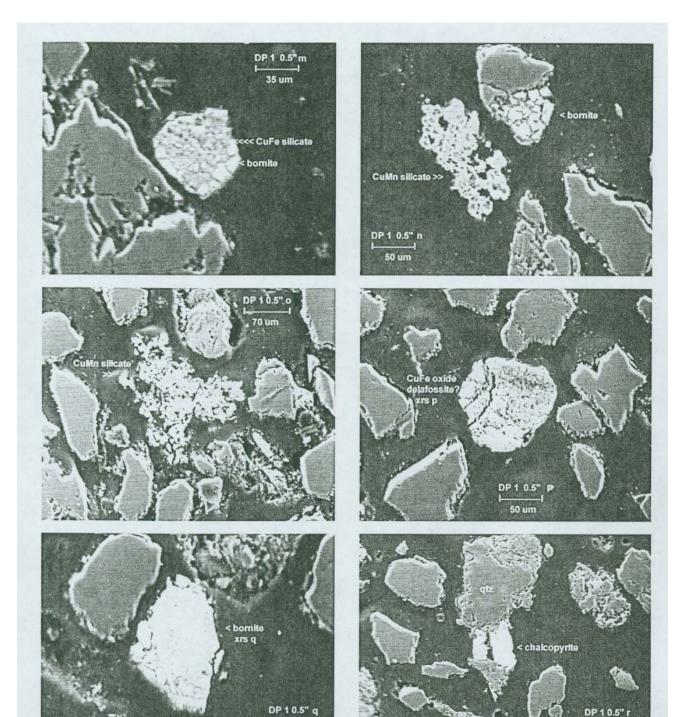
#### **PHOTOMICROGRAPHS**

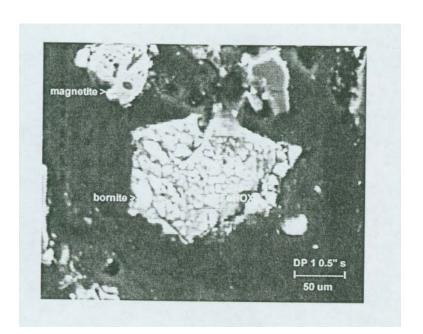
- a Quartz grain which partial copper carbonate (malachite?) encrustation.
- b Blue green copper silicate which may be chyrsocolla.
- c Greenish copper carbonate intergrown with quartz grains
- d Green copper carbonate (malachite?)
- e Blue green chrysocolla.
- f Chysocolla and quartz.
- g Chalcopyrite
- h Cu, Mn silicate and Cu, Mn oxide (delafossite?)
- i Cu, Mn silicate with ilmenite (bright) at left.
- J Cu, Mn oxide / silicate.
- k Mercury oxide or carbonate ?
- 1 CuMn
- m Bornite and a copper iron silicate.
- n Bornite at right and a cellular Cu, Mn Silicate at left.
- p Cu, Fe oxide. Delafossite?
- o Cu, Mn silicate.
- q Clastic bornite.
- r Chalcopyrite, quartz.
- s Bornite with spiderweb-like weathering texture.

Fout Comm

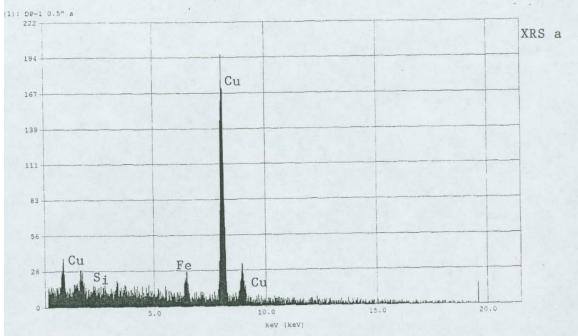




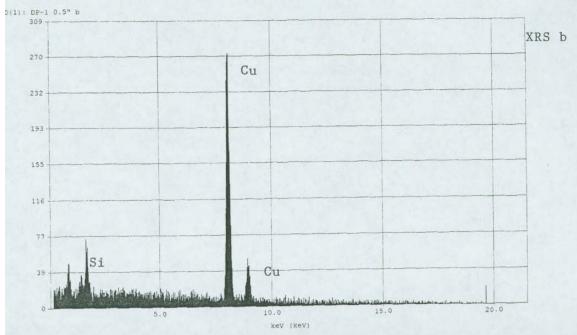




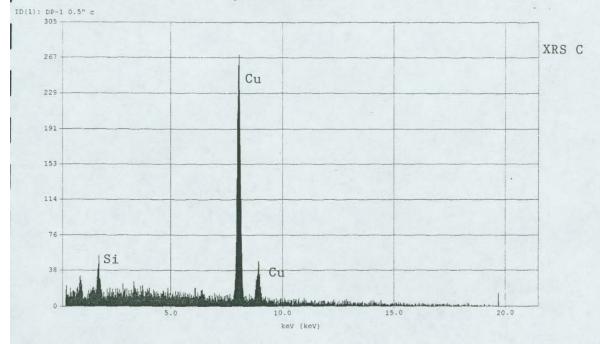
Spectrum Plot Routine



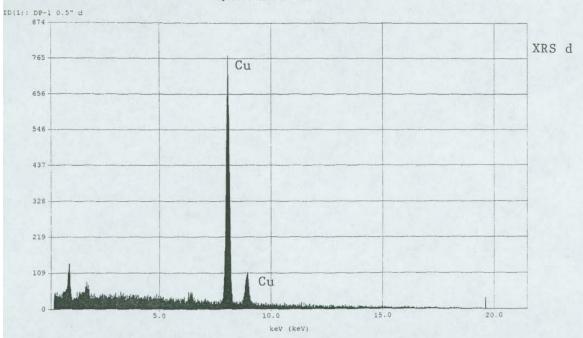
Cannon Microprobe ANS Quantum Software Report Thursday, November 27, 2003



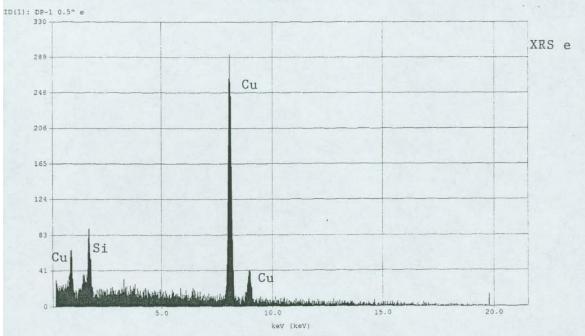
Spectrum Plot Routine



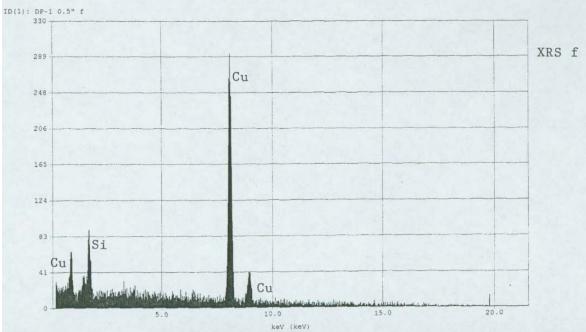
#### Cannon Microprobe ANS Quantum Software Report Thursday, November 27, 2003



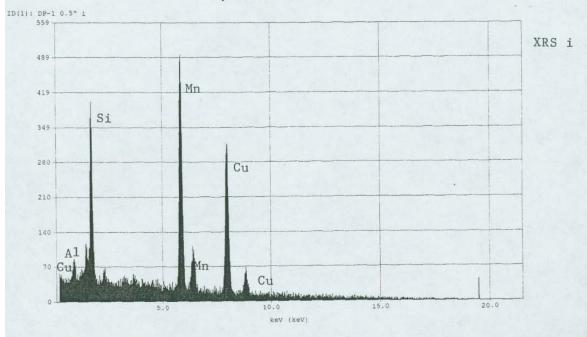
#### Spectrum Plot Routine



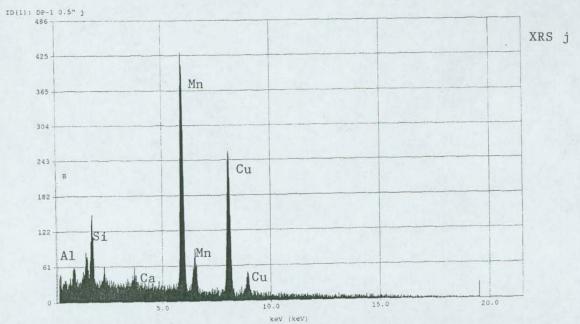
#### Cannon Microprobe ANS Quantum Software Report Thursday, November 27, 2003



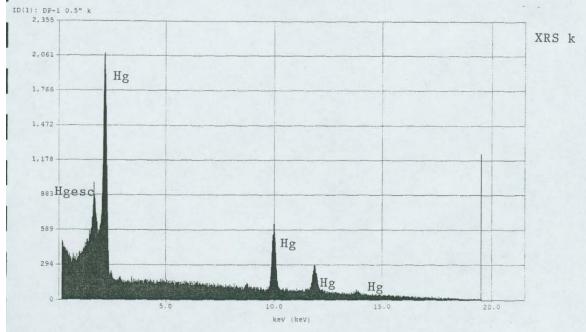
Spectrum Plot Routine



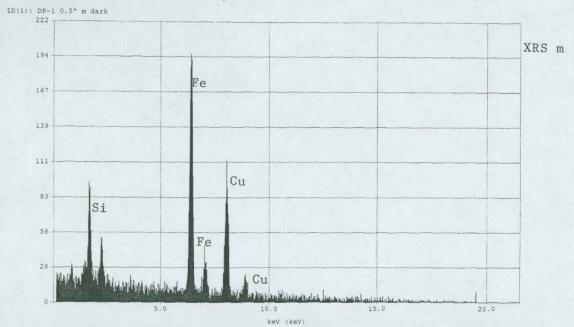
# Cannon Microprobe ANS Quantum Software Report Thursday, November 27, 2003



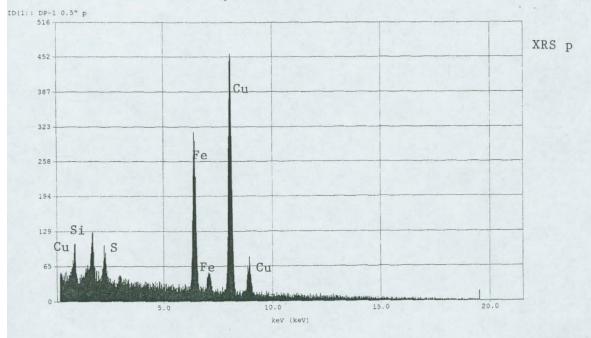
Spectrum Plot Routine



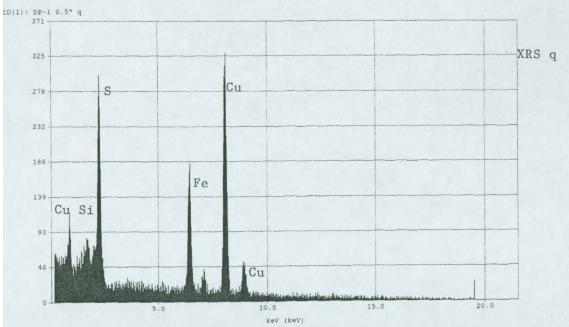
#### Cannon Microprobe ANS Quantum Software Report Thursday, November 27, 2003



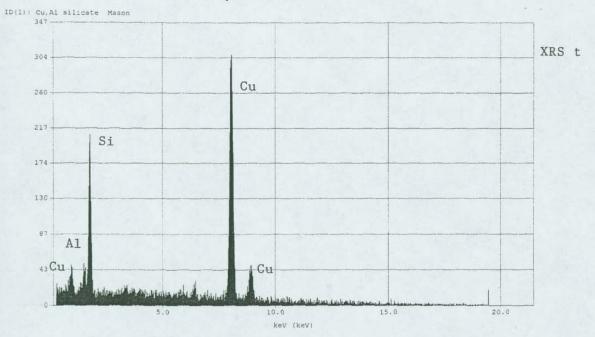
Spectrum Plot Routine



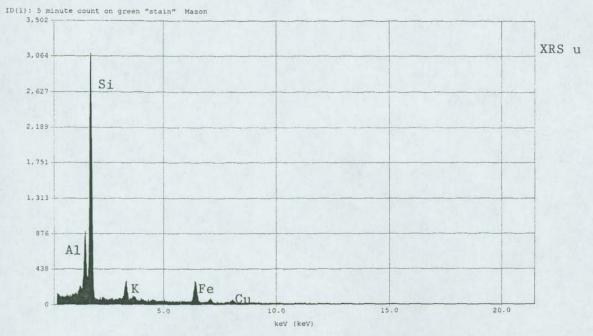
Cannon Microprobe
ANS Quantum Software Report
Thursday, November 27, 2003



#### Spectrum Plot Routine



## Cannon Microprobe ANS Quantum Software Report Monday, November 17, 2003



### **Appendix D**

# LABORATORY REPORTS FOR WATER QUALITY ANALYSES APRIL/MAY 2003

Assessment of Fate and Transport of Copper in Decant Pond Disposal System – Troy Mine Lincoln County, Montana

AEC

#### AMERICAN ENVIRONMENTAL CONSULTANTS LABORATORY

3422 South 700 West Salt Lake City, Utah 84119-4191

- (801) 261-1426 • FAX (801) 264-9838 -

May 19, 2003

RECEIVED MAY 2 7 2003

Mr. Bruce Clark
TROY UNIT

Please find attached the analytical results and quality control data for twenty-six water samples collected for the **TROY Mine Water** project on April 15, and April 16, 2003. The laboratory received the samples on April 18, 2003.

If you have any question, I can be reached at (801) 262-2459.

Sincerely,

Bilquis Dhedhy Chemist

Attach.

cc: GRStanga (w/attach.)

ANALYTICAL DATA REPORT

(Project TROY MINE)

Batch No: L030159

LAB NO

					,																																	
DALLE ANALYZED METHOD	•	29-APR-03 150.1	28-APR-03 6020			22-APR-03 160.1	28-APR-03 6020	29-APR-03 310.1	28-APR-03 6020	23-APR-03 6010B																			28-APR-03 6020		28-APR-03 6020				28-APR-03 6020		23-APR-03 6010B	29-APR-03 310.1
DAILE ANALYST ANALYZED METHOD		pH EH	MK			BD	MK	ррм СаСОЗ ЕН	ppm MK	ppm MK		CaCO3	ppm MK			ррт СаСОЗ ЕН									ppm MK	ppm MK			ppm MK	ррм СаСОЗ ЕН	MM mdd			CaCO3	ppm MK	ppm MK		Caco3
VALUE		6.3	<0.003	8.2	18.	63.	<0.010	30.	<0.003	42.	1.3	<2.0	900.0	0.012	141.	30.	23.	8.7	0.020	11.	0.075	0.058	<0.003	6.5	<0.003	0.47	142.	255.	<0.010	10.	<0.003	3.2	1.1	<2.0	0.002	0.017	6.6	10.
PARAMETER		Hd	SB(D)	SI-SIO2	SO4=	TDS	ZN(D)	ALK.	AS(D)	5	-10	CO3	Cn(D)	FE(D)	HARD	HCO3	Ж	MG	WN(D)	NA	NH3/N	NO2/NO3	PB (D)	Hd	SB(D)	SI-SI02	S04=	TDS	ZN(D)	ALK.	AS(D)	5	-TO	503	CO (D)	FE(D)	HARD	нсоз
DESCRIPTION		DECANT POND						ANOD JOHN DIEGON	Min 105 Folia																					SC-15								
DATE  LAB NO COLLECTED DES		T.030159-002 15-APR-03 DEC						TOW CO DOX HE COO CONTRACT																						T.020169-004 15-ADB-03								

ANALYTICAL DATA REPORT

(Project TROY MINE)

Batch No: L030159

K	DESCRIPTION
acr	PARAMETER
Ppm	VALUE
# ####################################	UNITS AN
ppm         MK         24-APR-03         6010B           ppm         MK         23-APR-03         6020           ppm         MK         28-APR-03         6020           ppm         MK         28-APR-03         6020           ppm         MK         23-APR-03         6010B           ppm         MK         23-AP	LYST ANALYZED M

Page 4 of 22

(Project TROY MINE)

Batch No: L030159

DATE
LAB NO COLLECTED DESCRIPTION

L030159-006 15-APR-03 SC-2

6010B	325.2	310.1		6010B	6010B	310.1	6010B	6010B	6010B	6010B		353.2	6020	150.1	6020		9036		6020	310.1	6020	6010B	325.2	310.1	6020	6010B	6010B	310.1	6010B	6010B	6010B	6010B	350.1	353.2	
23-APR-03		29-APR-03	28-APR-03	23-APR-03	23-APR-03	29-APR-03	24-APR-03	23-APR-03	23-APR-03	23-APR-03	29-APR-03	01-MAY-03	28-APR-03	29-APR-03	28-APR-03	23-APR-03	23-APR-03	22-APR-03	28-APR-03	29-APR-03	28-APR-03	23-APR-03	22-APR-03	29-APR-03	28-APR-03	23-APR-03	23-APK-03	29-APR-03	24-APR-03	23-APR-03	23-APR-03	23-APR-03	29-APR-03	01-MAY-03	
MK	NC	EH	MK	MK	MK	EH	MK	MK	MK	MK	ND	NS	MK	EH	MK	MK	N	BD	MK	EH	MK	MK	N	EH	MK	MK	MK	EH	MK	MK	MK	MK	NO	ND	
mdd	mdd	ppm CaCO3	mdd	mdd		ррш СаСОЗ	mdd	hd	mdd	mdd	mdd	mdd	mdd	ppm CaCO3	mdd	mdd		ppm CaC03	mdd	mdd		ppm CaCO3	mdd	mdd	mdd	mdd	mdd	mdd							
7.6	1.2	<2.0	<0.001	<0.010	27.	28.	<2.0	2.0	<0.00>	<2.0	0.000	0.091	<0.003	6.2	<0.00>	5.1	<2.0	26.	<0.010	30.	<0.003	7.6	1.1	<2.0	<0.001	<0.010	. 17	30.	<2.0	2.0	<0.00>	<2.0	<0.050	0.097	
CA	CL-	503	C(D)	FE(D)	HARD	нсоз	×	MG	MN(D)	NA	NH3/N	NO2/NO3	PB (D)	PH	SB(D)	SI-SI02	SO4=	TDS	ZN(D)	ALK.	AS(D)	5	-	003	(C(D)	FE(D)	HARD	HC03	×	MG	MN (D)	NA	NH3/N	NO2/NO3	

L030159-007 15-APR-03 FC-1

(Project TROY MINE)

Batch No: L030159

SG-8  C2		DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE UNITS ANALYST ANALYZED METHOD
PC-1   Ppm   NK   23-APR-03							
TDS 24.0 ppm 0.01 22-APR-03  LC-4  AAK. 34. 90.01 ppm NK 28-APR-03  LC-4 6.010 ppm NK 28-APR-03  CA 6.010 ppm NK 28-APR-03  CA 7. 0.011 ppm NK 28-APR-03  FE(D) 6.001 ppm NK 28-APR-03  FE(D) 6.001 ppm NK 28-APR-03  FE(D) 6.001 ppm NK 28-APR-03  KNO2/NO3 0.001 ppm NK 28-APR-03  KNO2/NO3 0.001 ppm NK 28-APR-03  NA3 6.000 ppm NK 28-APR-03  FE(D) 6.003 ppm NK 28-APR-03  KNO2/NO3 0.001 ppm NK 28-APR-03  FE(D) 6.003 ppm NK 28-APR	1159-007 15-APR-03	FC-1	SI-SI02	5.1	шаа	MK	
TNOS 26. Ppm 64 20.01			SO4=	<2.0	шаа	N	
National N			TDS	26.	mdd	BD	
Dec. 4   ALK.   34.   ALK.			ZN(D)	<0.010	mdd	MK	
Activity	159-008 15-APR-03	LC-4	***				
CL-   2.0   Ppm   MK   23-APR-03			ALK.	34.			
C.A.   8.9   Ppm   MK   23-APR-03			AS(D)	<0.003	mdd	MK	
CL-			5	6.8	mdd	MK	
CO   CO   CO   CO   DPM CACO   E   PAPR-0			-13	2.1			
PEP			503	<2.0			
Part			CQ (D)	<0.001	mdd	MK	
HARD   32,   Ppm   MK   23-APR-03			FE(D)	0.073	mdd	MK	
HOO3   34.   ppm GaCO3   EH   29-APR-03			HARD	32.			
MA			нсоз	34.			
MAN (D)			×	<2.0	mdd	MK	
NA			MG	2.3	mdd	MK	
NA			MN(D)	0.011	mdd	MK	
NH3/N   CO.050   Ppm   JN   29-APR-03			NA	<2.0	mdd	MK	
Phi			NH3/N	<0.050	mdd	N.S	
PB (D)   CO (O) 3   PP (D)			NO2/NO3	0.090	mdd	N	
SPH   6.3   PH   EH   29-APR-03			PB(D)	<0.003	mdd	MK	
SB(D)			Hd	6.3	ь	EH	
S1-SIO2 5.1 ppm MK 23-APR-03 S04= 2.0 ppm JN 23-APR-03 TDS TDS ZN(D) <0.010 ppm BD 22-APR-03 ZN(D) <0.010 ppm MK 22-APR-03 AS(D) <0.003 ppm MK 28-APR-03 CA 3.1 ppm MK 23-APR-03 CO3 <2.0 ppm MK 23-APR-03 CO3 <2.0 ppm CaCO3 EH 29-APR-03 CO4D) <0.001 ppm MK 23-APR-03 CO5D <0.50 ppm MK 24-APR-03			SB(D)	<0.003	mdd	MK	
SO4			SI-SIOZ	5.1	mdd	MK	
TDS			SO4=	2.0	mdd	NS	
EP-1  ALK. 74. ppm CaCO3 EH 29-AFR-03  AS(D) <0.003 ppm MK 28-AFR-03  CA 49. ppm MK 23-AFR-03  CA 3.1 ppm MK 23-AFR-03  CO3 <2.0 ppm MK 23-AFR-03  CO3 <2.0 ppm MK 29-AFR-03  CU(D) <0.001 ppm MK 29-AFR-03  HARD 173. ppm MK 23-AFR-03  HARD 173. ppm MK 23-AFR-03  HCO3 74. ppm MK 23-AFR-03  KC 22. ppm MK 23-AFR-03  HARD 173. ppm MK 23-AFR-03			TDS	41	mdd	BD	
EP-1  ALK. 74. ppm CaCO3 EH 29-APR-03  CA 49. ppm MK 28-APR-03  CA 49. ppm MK 23-APR-03  CA 49. ppm MK 23-APR-03  CA 49. ppm MK 23-APR-03  CO3 <2.0 ppm CaCO3 EH 29-APR-03  CU(D) <0.001 ppm MK 28-APR-03  FE(D) <0.001 ppm MK 28-APR-03  FE(D) <0.50 ppm MK 23-APR-03  HARD 173. ppm MK 23-APR-03  HCO3 74. ppm CaCO3 EH 29-APR-03  KC 24-APR-03  KC 24-APR-03  KC 24-APR-03			ZN(D)	<0.010	mdd .	MK	
(0.003 ppm MK 28-APR-03 49. ppm MK 23-APR-03 3.1 ppm CaCO3 EH 29-APR-03 (0.001 ppm MK 28-APR-03 (0.50 ppm MK 28-APR-03 (0.50 ppm MK 23-APR-03 (173. ppm CaCO3 EH 29-APR-03 (174. ppm CaCO3 EH 29-APR-03 (175. ppm MK 23-APR-03 (176. ppm MK 23-APR-03 (177. ppm CaCO3 EH 29-APR-03 (177. ppm CaCO3 EH 29-APR-03 (177. ppm MK 24-APR-03 (177. ppm MK 24-A	159-009 15-APR-03	EP-1	ALK.	74.	Dom Cac		
49. ppm MK 23-APR-03 3.1 ppm CaCO3 EH 22-APR-03 <0.001 ppm MK 23-APR-03 0.50 ppm MK 28-APR-03 0.50 ppm MK 28-APR-03 173. ppm ACO3 EH 29-APR-03 274. ppm CaCO3 EH 23-APR-03 274. ppm CaCO3 EH 29-APR-03 22. ppm MK 24-APR-03 22. ppm MK 23-APR-03 24. ppm CaCO3 EH 29-APR-03 25. ppm MK 24-APR-03			AS(D)	<0.003	maa		
3.1 ppm caCO3 EH 29-APR-03 c0.001 ppm CaCO3 EH 29-APR-03 0.50 ppm MK 28-APR-03 ppm MK 23-APR-03 ppm MK 23-APR-03 ppm CaCO3 EH 29-APR-03 c2. ppm CaCO3 EH 29-APR-03 c2.			5	49.	mdd	MK	
<ul> <li>(2.0</li> <li>(2.0)</li> <li>(2.0)</li> <li>(3.0)</li> <li>(4.0)</li> <li>(5.0)</li> <li>(6.0)</li> <li>(7.1)</li> <li>(</li></ul>			-TO	3.1	maa	M.	
(0.00) Ppm MK 28-APR-03 0.50 Ppm MK 23-APR-03 173. Ppm CaCO3 EH 23-APR-03 22. Ppm MK 23-APR-03 74. Ppm CaCO3 EH 29-APR-03			C03	<2.0			
0.50 ppm MK 23-APR-03 173. ppm CaCO3 EH 29-APR-03 22. ppm KK 24-APR-03			CU(D)	0000			
173. ppm MK 23-APR-03 74. ppm CaCO3 EH 29-APR-03 22. ppm KK 24-APR-03			FE(D)	0 50	mdd	S. S. S.	
173. Ppm AMK 23-ARR-03 74. Ppm CaCO3 EH 29-ARR-03 22. Ppm X 24-ARR-03			HARD		hom	MM	
22. ppm caco3 EH 29-APR-03 22.			HOO3	1/3.	mdd		
22. ppm MK 24-APR-03			nco3	74.	ppm CaCo		
			V	22.	mdd	MK	

AMERICAN ENVIRONMENTAL CONSULTANTS

GENESIS INC.

(Project TROY MINE)

Batch No: L030159

DATE
TAB NO COLLECTED DESCRIPTION

L030159-009 15-APR-03 EP-1

L030159-010 16-APR-03 IW-1

ANALYZED METHOD		23-ADP-03 CO.	23-APR-03 6010B									22-APR-03 160.1	28-APR-03 6020		30-APR-03 310,1	28-APR-03 6020									95	23-APR-03 6010B		29-APR-03 350.1		28-APR-03 6020								30-APR-03 310.1	28-APR-03 6020
HWH		Dpm mgg				Dpm MK	на на	Dpm mdd	ppm MK	NE wdd				Ppm Caco3 FH				0000	Cacos		PDm MK	Control		DDM					DDG DDG							Ppm MK	and	DDM CACOS EH	
	1.0	18.	1.4	0.24	<0.003	6.3	<0.003	6.7	144	316	310.	20.010	0,0	. 000	\$0.003	.82	3.9	<2.0	<0.001	. <0.010	.86	. 89	<2.0	7.1	<0.00>	62.0	<0.050	1.0	<0.003	7.5	<0.00>	10.	27.	131.	<0.010		120.	900.0	.00.
	MN (D)	NA	NH3/N	NO2/NO3	PB(D)	HA	SB(D)	SI-S102	SO4=	TDS	ZN(D)		ALK.	AS(D)	5	t)	500	(4)10	EE (E)	FE(D)	HC03	N M	MG	MN (D)	NA NA	NH3/N	NO2/NO3	PB(D)	PH	SB(D)	SI-STO	SO4=	TDS	ZN (m)	(T) NIZ	N T W	AS (D)	C P	CIT

L030159-011 16-APR-03 MW-1

(Project TROY MINE)

UNITS AMALIST ANALIZED METHOD	30-APR-03 310.1	28-APR-03 6020	23-APR-03 6010B			24-APR-03 6010B												28-APR-03 6020	30-APR-03 310.1	28-APR-03 6020	23-APR-03 6010B	22-APR-03 325.2															100000000000000000000000000000000000000
NALYST	EH	MK	MK	MK	EH	MK	MK	MK	MK	NC	N,	MK	ЕН	MK	MK	N	BD	MK	EH	MK	MK	UN	EH	MK	MK	MK	EH	MK	MK	MK	MK	N5	N.	MK	EH	MK	
	ppm CaCO3	mdd	mdd	mdd	ppm CaCO3	mdd ·	mdd	mdd	wdd	mdd	mdd	wdd	Hď	mdd	mdd	mdd	mdd	mdd	ppm CaCO3	шdd	шdd	шdd	ppm CaCO3	mdd	mdd	шdd	ppm CaC03	mdd	шdd	mdd	mdd	mdd	шфф	mdd	Hd	mdd	
VALIDE	<2.0	<0.001	6.5	110.	120.	<2.0	5.6	0.56	6.1	<0.050	0.19	<0.003	7.4	<0.003	21.	5.6	142.	0.011	16.	<0.003	5.9	1.1	<2.0	0.012	4.5	20.	16.	<2.0	1.3	0.28	1.0	0.082	<0.050	900.0	6.2	<0.003	
PARAMETER	003	CO (D)	FE(D)	HARD	нсоз	M	MG	MN(D)	NA	NH3/N	NO2/NO3	PB (D)	PH	SB(D)	SI-SIO2	SO4 =	TDS	ZN(D)	ALK.	AS(D)	ð	-1	003	CU(D)	FE(D)	HARD	HC03	Ж	MG	WN(D)	NA	NH3/N	NO2/NO3	PB(D)	PH	SB(D)	
ION																																					
DESCRIPTION	MIN-1	7																	MW. 2																		
COLLECTED	A DD - 03	TO WIN																	ADD-03																		
	10301EG_011 16_ADD-03	-01 110-6																	10301E0 013 16-80B-03	24																	
LAB NO	10201	103013																	21050	1																	

(Project TROY MINE) Batch No: L030159 DATE

VALUE

PARAMETER

COLLECTED DESCRIPTION

LAB NO

MW-3

L030159-013 16-APR-03

L030159-012 16-APR-03

UNITS AMALYST ANALYZED METHOD 30-APR-03 310.1
28-APR-03 6020
23-APR-03 6010B
22-APR-03 310.1
28-APR-03 310.1
23-APR-03 6010B
30-APR-03 6010B
30-APR-03 6010B
23-APR-03 6020
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33-APR-03 6020
33-APR-03 6020
33-APR-03 6020 22-APR-03 160.1 28-APR-03 6020 30-APR-03 310.1 28-APR-03 6020 23-APR-03 6010B 22-APR-03 310.1 30-APR-03 10.1 23-APR-03 6020 23-APR-03 6010B 106. 0.018 31. 2.5 <2.0 6.001 12. 106. <2.0 3.6 0.56 0.56 0.56 0.056 0.005 0.005 0.003 0.0 164. 0.025 30. 1.1 1.1 <2.0 <0.001 <0.010 112. 164. 2.5 2.5 K MG MA NA NA NH3/N NO2/NO3 PPB(D) PP (D) PP (D) SB (D) SI - SI O2 SO4 = TDS ZN (D) ALK.
AS (D)
CA
CLCO3
CU(D)
FE (D)
HARD ALK.
AS(D)
CA
CL.
CO3
CCO3
CCU(D)
FE(D)
HARD MW-2

MW-4

L030159-014 16-APR-03

GENESIS INC.

(Project TROY MINE)

Batch No: L030159

DATE	TCAD METHOD	29-ADR-03 350 1						23-APR-03 9036		28-APR-03 6020	30-ABR-03 310 1									24-APR-03 6010B	23-APR-03 6010B	23-APR-03 6010B		29-APR-03 350.1			30-APR-03 150.1	28-APR-03 6020	23-APR-03 6010B	23-APR-03 9036	22-APR-03 160.1	28-APR-03 6020	30-8BB-03 310 1				
d D	TOT PUBL									28-A	30-4	28-A	23-A	22-A	30-A	28-A	23-A	23-A	30-A	24-A	23-A	23-A	23-A	29-A	01-M	28-A	30-A	28-A	23-A	23-A	22-A	28-A	30-8	28-AI	23-A	22-AI	
That the same	CHAIS AMELICAD METHOD	NE waa	NC mdd			ppm mdd		NC mdd		ppm mgg	DDM CACO3 EH		-		ppm CaCO3 EH		MK mdd	MK mdd	ppm CaCO3 EH	MK mdd	ppm mgg		MK mdd	MC mdd							DDm mdd	ppm mgg	DDM CACO3 EH		ppm MK	NC mdd	
VAITIE	200	0.78	<0.050	<0.003	8.0	<0.003	10.	<2.0	173.	<0.010	148.	<0.003	41,	3.1	<2.0	<0.001	<0.010	154.	148.	40.	13.	0.29	20.	9.9	<0.050	<0.003	7.5	<0.003	7.7	111.	318.	<0.010	20.	0.009	35.	3.2	
PARAMETER		NH3/N	NO2/NO3	PB(D)	ЬН	SB(D)	SI-SI02	S04=	TDS	ZN(D)	ALK.	AS(D)	5	-15	503	CA(D)	FE(D)	HARD	HCO3	× !	MG	MN(D)	NA	NH3/N	NO2/NO3	PB(D)	PH.	SB(D)	2015-3102	504=	TDS	ZN(D)	ALK.	AS(D)	5	-To	
DESCRIPTION		MW-4									TRMW 95-3																						TRMW 95-4				
DATE LAB NO COLLECTED		L030159-014 16-APR-03									L030159-015 16-APR-03																						L030159-016 16-APR-03				

(Project TROY MINE)

Batch No: L030159

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L030159-016 16-APR-03 TRMW 95-4

L030159-017 15-APR-03 LC-2

GENESIS INC.

(Project TROY MINE)

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DATE TAB NO COLLECTED DESCRIPTION	PARAMETER	VALIUE	UNITS	NALYST	DATE NAALYZED METHOD	
L030159-018 15-APR-03 LC-1	ALK.	32.	ppm CaCO3	EH	29-APR-03 310.1	
	AS(D)	<0.003		MK		
	CA	8.7	шdd	MK	23-APR-03 6010B	
	- B	1.1	mdd	ND	22-APR-03 325.2	
	503	<2.0	ppm CaCO3	EH	29-APR-03 310.1	
	CO (D)	<0.001	mdd	MK		
	FE(D)	0.041	mdd	MK	23-APR-03 6010B	
	HARD	30.		MK		
	нсоз	32.	ppm CaCO3	EH	29-APR-03 310.1	
	×	<2.0	mdd	MK		
	MG	2.1	mdd	MK		
	MN(D)	600.0	mdd	MK		
	NA	<2.0	шdd	MK	23-APR-03 6010B	
	NH3/N	0.097	mdd	CN	29-APR-03 350.1	
	NO2/NO3	0.063	mdd	UN	01-MAY-03 353.2	
	PB(D)	<0.003	mdd	MK	28-APR-03 6020	
	PH	6.3	hd	EH	29-APR-03 150.1	
	SB(D)	<0.003	mdd	MK	28-APR-03 6020	
	SI-SI02	4.6	mdd	MK	23-APR-03 6010B	
	S04=	<2.0	mdd	N.		
	TDS	30.	mdd	BD	22-APR-03 160.1	
	ZN(D)	<0.010	mdd	MK		
L030159-019 16-APR-03 TRMW 95-5	ALK.	30.	DDM CaCO3	EH	30-APR-03 310.1	
	AS(D)	<0.003		MK		
	CA	4.6	mdd	MK		
	-T	4.6	mdd	JN	22-APR-03 325.2	
	003	<2.0	ppm CaCO3	EH	30-APR-03 310.1	
	CU(D)	<0.001	mdd	MK	28-APR-03 6020	
	FE(D)	0.081	mdd	MK	23-APR-03 6010B	
	HARD	16.		MK		
	нсоз	30.	ppm CaCO3	EH	30-APR-03 310.1	
	×	4.5	mdd	MK	24-APR-03 6010B	
	MG	1.2	mdd	MK	23-APR-03 6010B	
	MN(D)	0.14	шdd	MK	23-APR-03 6010B	
	NA	3.3	mdd	MK	23-APR-03 6010B	
	NH3/N	0.10	mdd	N		
	NO2/NO3	0.40	mdd	NS	01-MAY-03 353.2	
	PB (D)	<0.003	шđđ	MK	28-APR-03 6020	

(Project TROY MINE) Batch No: L030159

DATE
LAB NO COLLECTED DESCRIPTION

L030159-019 16-APR-03 TRMW 95-5

TRMW 97-12

L030159-020 16-APR-03

150.1	6020	6010B	2006	6020	310.1	6020	6010B	325.2	310.1	6020	6010B	6010B	310.1	6010B	6010B	6010B	6010B	350.1	353.2	6020	1.001	0709	90700	160.1	6020	310.1	6020	6010B	325.2	310.1	6020	6010B
30-APR-03	28-APR-03 (			28-APR-03 (	30-APR-03						23-APR-03 (					23-APR-03						28-APR-03				30-APR-03	28-APR-03					23-APR-03
EH	MK	MK	NO.	M W	EH	MK	MK	NS	EH	MK	MK	MK	EH	MK	MK	MK	MK	N/S	K !	MK	H	MK	AIN.	BD	MK	EH	MK	MK	JN	EH	MK	MK
hd	mdd	mdd	mdd	mdd	ppm CaCO3		mdd	mdd	ppm CaCO3	mdd	mdd		ppm CaC03	шdd	mdd	mdd	mdd	mdd	mdd	mdd	рн	mdd	mdd	mdd	шđđ	ppm CaCO3	mdd	mdd	mdd	ppm CaCO3	mdd	mdd
6.2	<0.003	49.	7.6	<0.010	24.	0.005	16.	3.0	<2.0	0.037	9.9	.99	24.	5.4	3.9	0.53	2.9	0.076	<0.050	0.007	6.3	<0.003	43.	108.	0.051	45.	<0.003	30.	1.3	<2.0	<0.001	<0.010
PH	SB(D)	SI-SI02	SO4 =	ZN(D)	ALK.	AS(D)	CA	-TJ	503	CU (D)	FE(D)	HARD	нсоз .	Ж	MG	MN(D)	NA	NH3/N	NO2/NO3	PB(D)	Hd.	SB(D)	2015-102	TDS	ZN(D)	ALK.	AS(D)	CA	-To	503	(Q) (D)	FE(D)

L030159-021 16-APR-03 TRMW 97-14

AMERICAN ENVIRONMENTAL CONSULTANTS

ANALYTICAL DATA REPORT

GENESIS INC.

(Project TROY MINE)

Batch No: L030159

DATE DATE					DATE	
	PARAMETER	VALUE	UNITS	ANALYST	UNITS ANALYST ANALYZED METHOD	D
L030159-021 16-APB-03 TPMW 07 14						
	М	2.4	mdd	MK	24-APR-03 6010B	
	WG	7.8	mdd	MK	23-APR-03 6010B	
	MIN (D)	<0.005	mdd	MK		
	NA	7.9	mdd	MK	23-APR-03 6010B	
	NH3/N	0.14	mdd	NL		
	NO2/NO3	2.4	шdd	J.		
	PB(D)	<0.003	mdd	MK		
	Hď	6.5	Hd	EH		
	SB(D)	<0.003	mdd	MK		
	SI-SIO2	12.	mdd	MK		
	SO4=	83.	mdd	NL		
	TDS	191.	mdd	BD		
	ZN(D)	<0.010	mdd	MK		
L030159-022 15-APR-03 SERVICE ADIT-P (7 East)	ALE	10				
	, Way 84	.00	ppm CaCO3			
	AS (U)	0.004	шфф	MK		
	5 8	30.	mdd	MIK	23-APR-03 6010B	
		1.1	шdd	NS	22-APR-03 325.2	
	603	<2.0	ppm CaCO3	EH		
	(CD(D)	0.051	mdd	MK		
	FE(D)	<0.010	mdd	MK		
	HARD	109.	mdd	MK		
	НСОЗ	78.	ppm CaCO3			
	Y	<2.0	mdd	MK	24-APR-03 6010B	
	MG	8.4	шdd	MK	23-APR-03 6010B	
	MN (D)	0.011	mdd	MK	23-APR-03 6010B	
	NA Service Association	<2.0	mdd	MK	23-APR-03 6010B	
	NH3/N	<0.050	mdd	SN	29-APR-03 350.1	
	NOZ/NO3	1.1	mdd	NO	01-MAY-03 353.2	
	PB (D)	<0.003	ppm	MK		
	Hd	7.6	Hd .	EH		
	SB(D)	0.016	шdd	MK		
	SI-SI02	5.3	mdd	MK		
	SO4=	29.	mdd	NC		
	TDS	147.	mdd	BD		
	ZN(D)	<0.010	mdd	MK		
L030159-023 15-APR-03 SERVICE ADIT-D						
	ALK.	28.	ppm CaCO3	EH	29-APR-03 310.1	
	AS(D)	<0.003	wdd	MK	28-APR-03 6020	

(Project TROY MINE)

Batch No: L030159

LAB NO COLLECTED DESCRIPTION

L030159-023 15-APR-03 SERVICE ADIT-D

CA. 14. ppm MK CG. 41.0 ppm CaCO3 EH CCO3	23-APR-03 6010B		29-APR-03 310.1			23-APR-03, 6010B		24-APR-03 6010B	23-APR-03 6010B	23-APR-03 6010B	23-APR-03 6010B	29-APR-03 350.1								28-APR-03 6020	29-APR-03 310.1			13-MAY-03 325.2											01-MAY-03 353.2
14. (11.0 (21.0 (22.0 (0.13) (0.13) (0.0	MK		EH				EH								EH	MK	MK	NC	BD	MK			MK	ND		MK	MK	-			MK	MK	MK	ND	JN
	mdd	mdd		mdd	mdd	шdd	ppm Ca	mdd	шdd	шdd	mdd	wdd	mdd	mdd	Hd	mdd	mdd	mdd	mdd	mdd	ppm C	mdd	'mdd	mad	D mqq	mdd	mdd	mdd	D mdd	mdd	mdd	mdd	mdd	mdd	mdd
CA. CCA. CCD. CCO3. CU(D) FF(D) HARD. HCO3. K K MG MM (D) NA. NAA. NAA. NAA. NAA. NAA. NAA. NAA.	14.	<1.0	<2.0	0.13	<0.010	45.	28.	<2.0	2.6	0.17	<2.0	<0.050	0.13	<0.003	6.8	<0.003	9.9	20.	81.	0.013	24.	<0.003	12,	<1.0	<2.0	0.004	<0.010	42.	24.	<2.0	2.8	0.33	<2.0	0.084	<0.050
	5	-TJ	503	CU(D)	FE(D)	HARD	нсоз	Ж	MG	MN(D)	NA	NH3/N	NO2/NO3	PB(D)	Hd	SB(D)	SI-S102	SO4=	TDS	ZN(D)	ALK.	AS(D)	CA	-TO	003	CO (D)	FE(D)	HARD	HCO3	Ж	MG	MN(D)	NA	NH3/N	NO2/NO3

L030159-024 15-APR-03 TRANSFER POINT

GENESIS INC.

(Project TROY MINE)

Batch No: L030159

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	МЕТНОБ	6010B	9036	160.1	6020	310.1	6020	6010B	325.2	310.1	6020		6010B	310.1	6010B	6010B	6010B			353.2	6020	150,1	6020				6020	310.1	6020	6010B	325.2	310.1	6020	6010B	6010B	310.1	6010B	6010B
DATE	ANALYZED	23-APR-03	23-APR-03	22-APR-03	28-APR-03	29-APR-03	28-APR-03	23-APR-03	13-MAY-03	29-APR-03	28-APR-03	23-APR-03	23-APR-03	29-APR-03	24-APR-03	23-APR-03	23-APR-03	23-APR-03	29-APR-03	01-MAY-03	28-APR-03	29-APR-03	28-APR-03	23-APR-03	23-APR-03	22-APR-03	28-APR-03	29-APR-03	28-APR-03	23-APR-03	13-MAY-03	29-APR-03	28-APR-03	23-APR-03	23-APR-03	29-APR-03	24-APR-03	23-APR-03
	NALIST	MK	CIN	BD	MK	EH	MK	MK	UN	EH	MK	MK	MK	EH	MK	MK	MK	MK	JN	ND	MK	EH	MK	MK	NC	BD	MK	EH	MK	MK	J.N.	EH	MK	MK	MK	EH	MK	MK
	UNITS ANALYST ANALYZED METHOD	шdd	mdd	mdd	mdd	ppm CaCO3	mdd	шфф	mdd	ppm CaC03	шdd	шdd	шdd	ppm CaCO3	mdd	шdd	mdd	шфф	mdd	mdd	шdd	Hď	mdd	mdd	mdd	шфф	mdd	ppm CaCO3	mdd	mdd	mdd	ppm CaCO3	mdd	шdd	mdd	ppm CaCO3	mdd	шdd
	VALICUE	12.	25.	85.	0.012	70.	0.005	25.	<1.0	<2.0	0.078	<0.010	82.	70.	<2.0	4.8	900.0	<2.0	0.074	0.39	<0.003	7.2	0.026	4.6	14.	107.	<0.010	.06	<0.003	28,	<1.0	<2.0	0.041	<0.010	97.	.06	<2.0	6.7
THE PASSAGE AND ADDRESS OF THE PASSAGE AND ADDRE	PARAMETER	SI-SI02	504=	TDS	ZN(D)	ALK.	AS(D)	5	CL-	503	CU(D)	FE(D)	HARD	HC03	X	MG	MN(D)	NA	NH3/N	NO2/NO3	PB(D)	PH	SB(D)	SI-SI02	S04=	TUS	ZN(D)	ALK.	AS(D)	5	-170	CO3	CU(D)	FE(D)	HARD	нсоз	×	MG
		T																																				
PERCENTAGE TO SERVICE STATES	COMPENSED OF SCRIPTION	TRANSFER POINT				9 EAST																						UQ-1										
Correction	COMPETER	15-APR-03				15-APR-03																						15-APR-03										
	LAB PIO	L030159-024 15-APR-03				L030159-025 15-APR-03																						L030159-026 15-APR-03										

GENESIS INC.

(Project TROY MINE)

Batch No: L030159

DATE COLLECTED DESCRIPTION

LAB NO

UQ-1

L030159-026 15-APR-03

23-APR-03 23-APR-03 29-APR-03 01-MAY-03 28-APR-03 29-APR-03 29-APR-03 23-APR-03 23-APR-03 23-APR-03 23-APR-03 23-APR-03
MK JN JN MK EH HE JN JN BD
wdd
NA (2.049) NA (2.049) NA (2.041) NB(D) (0.003) PH (D) (0.003) PH (D) (0.003) SA(D) (0.009) SA(SA(D) (0.009) SA(SA(D) (0.009) T.3 (0.009) T.3 (0.009) T.3 (0.009) T.3 (0.009) T.3 (0.009) T.3 (0.009) T.4 (0.009) T.5 (0.009)

PH is a field parameter therefore holding time cannot be met by the laboratory.

Portions of the dissolved samples were analyzed as received in accordance with EPA methods 6010B and 6020.

Ca, Mg, Hardness, Na, K, SI-SIO2 represent dissolved constituents.

Unless otherwise noted results are not blank corrected.

Page 17 of 22

GENESIS INC.

(Project TROY MINE)

Batch No: WG030177

						7																															
тнор	20	6010B	325.2	6020	6010B	6010B.	6010B	6010B	6010B	350.1	353.2	6020	6020	6010B	9036	6020	110.1	200	6010B	325.2	310.1	6020	6010B	6010B	310.1	6010B	6010B	6010B	6010B	350.1	353.2	6020	6020	6010B	9036	1.091	20
DATE NALYZED ME	28-APR-03 6020	23-APR-03 60	22-APR-03 32		23-APR-03 60	24-APR-03 60	23-APR-03 60:	23-APR-03 60	23-APR-03 60:	29-APR-03 35	01-MAY-03 35	28-APR-03 60;		23-APR-03 60	23-APR-03 90.	28-APR-03 60	29-APR-03 31						23-APR-03 60	23-APR-03 60		24-APR-03 60				29-APR-03 35	01-MAY-03 35		28-APR-03 60;	23-APR-03 60	23-APR-03 90.		28-APR-03 6020
LYST																																				BD 2	
DATE VALUE ANALYST AMALYED METHOD	*Recovery MK	*Recovery MK	*Recovery J	*Recovery MK	*Recovery MK	*Recovery MK	*Recovery MK	*Recovery MK	*Recovery MK	*Recovery JN	*Recovery JN	*Recovery MK	*Recovery MK	*Recovery MK	*Recovery JN	*Recovery MK	DDM CACO3 EH				CaCO3		ppm mK	ppm MK	ppm CaCO3 EH	ppm mK	ppm MK	ppm MK	ppm mK		NL mdd	ppm MK		ppm mgg	NC mdd		
															-	***				14.5													1				
antiva	102	SR>4XSA	102	100	86	2.6	SR>4XSA	26	SR>4XSA	116	110	98	26	SR>4XSA	96	122	<2.0	<0.003	<1.0	<1.0	<2.0	<0.001	<0.010	<5.0	<2.0	<2.0	<1.0	<0.005	<2.0	<0.050	<0.050	<0.003	<0.003	<0.10	<2.0	<10	<0.010
PARAMETER	AS(D)	5	-13	CU(D)	FE(D)	X	MG	MN(D)	NA	NH3/N	NO2/NO3	PB (D)	SB(D)	SI-SI02	SO4=	ZN(D)	ALK.	AS(D)	C P	-To	C03	CO (D)	FE(D)	HARD	HC03	Ж	MG	MN (D)	NA	NH3/N	NO2/NO3	PB(D)	SB(D)	SI-S102	SO4=	TDS	ZN(D)
-	ke																																				
DESCRIPTION	Matrix Spike																Pren Blank	4																			
DATE																																					
LAB NO	WG030177-1																WG030177-2																				

	DATE	ANALYZED METHOD			29-APR-03 310 1					29 APR-03 6010B	24-APP 03 310.1		23-APR-03 6010B				28-APR-03 6020		23-APR-03 6010B	22-App 02 - 22-App 02 -	28-APR-03 160.1	0709 52	29-APR-03 310 -	22-APR-03 325 2				01-MAY-03 353.2	23 APR-03 9036	22-APR-03 160.1	28-8 pp. s-	23.APR -03 6020	28-APR-03 6010B	23-APB 03 6020	24-APR-03 6010B		23-APR-03 6010B	23-APR-03 6010B	28-APB 03 6020	- TER-03 6020
	UNITS ANALYST			*Recovery	*Recovery MY						*Recovery MK		*Recovery MK							*Pecovery BD	weery MK	* RPD		RPD DE					RPD BD		ARD MK	MK		MK	MK	MM	MK	MK	RPD MK 28	
	VALUE		66	103	100	100	105	66	66	100	66	102	100	96	106	100	102	114	103	103	7	***	- Prdi	<1	+/-prd1	+/-prd1	9.0	1.3	*	1.0	0 01	P	Pak	4	ele.	olo	ollo	3.0	* R	
	PARAMETER		ALK.	AS (D)	5 5	14/16/	FE(D)	HC03	K	MG	MN(D)	NA	NH3/N NOS (ME	DB (T)	SB(D)	SI-SIO2	S04=	TDS	ZN(D)		ALK.	÷ 1	003	NH2 (**	NO2/NO2	SO4=	TDS		AS(D)	CA	CU(D)	FE(D)	ж	MG	MN (D)	DD /rui	SR(D)	(0)		
																																								-
PTION	Lab Control Sample																										Duplicate													
DATE COLLECTED DESCRIPTION	Lab Con																	Duplicato	- Fricace								Macrix Spike Duplicate													
CAN BALL	WG030177-3																WG030177_4	-							WG030122	5-2/10500														

AMERICAN ENVIRONMENTAL CONSULTANTS ANALYTICAL DATA REPORT

(Project TROY MINE) Batch No: WG030177

GENESIS INC.

AMERICAN ENVIRONMENTAL CONSULTANTS

ANALYTICAL DATA REPORT

GENESIS INC.

(Project TROY MINE)

Batch No: WG030177

Natrix Spike Duplicate   Si-SiO2   1.0   \$ k RPD   NKK   23-ARR-03 60108						
ALK.	Matrix Spil	ke Duplicate	SI-S102	1.0	RPD	. 6010E
ALK. 2.0 ppm CaCO3  CA. 1.0 ppm CA. 1.0 ppm CA. 1.0 ppm CA. 2.0 ppm CA. 2.0 ppm CA. 2.0 ppm FE(1) 0.001 ppm FE(2) 0.010 ppm HARD 5.0 ppm HARD 5.0 ppm HARD 2.0 ppm MA			ZN(D)	20	RPD	6020
AS(D) 0.003 ppm  CL- CL- 1.0 ppm  CCO3 2.0 ppm  CU(D) 0.001 ppm  HARD 5.0 ppm  HARD 5.0 ppm  MN (D) 0.005 ppm  MN (D) 0.005 ppm  MN (D) 0.005 ppm  MN (D) 0.005 ppm  NO2/NO3 0.003 ppm  SB (D) 0.003 ppm  CL- SO Ppm  SB (D) 0.003 p	Reporting 1	Limit	ALK.	2.0	ppm CaCO3	310.1
CA 1.0 Ppm CCA 1.0 CDA CCA 1.0 CDA CCA 1.0 Ppm CCACO3 CCO3 CCO3 CCO3 CCO3 CCO3 CCO3 CC			AS(D)	0.003	mdd	6020
CUL 1.0 ppm CaCO3 CUL 1.0 ppm CaCO3 CU(D) 0.001 ppm FE(D) 0.010 ppm HACO3 2.0 ppm MACO 1.0 ppm M			. 45	1.0	mdd	60101
CU(D) 0.001 ppm CaCO3 CU(D) 0.010 ppm CaCO3 HARD 5.0 ppm CaCO3 HCO3 2.0 ppm CaCO3 MN (M) 0.005 ppm MN (M) 0.005 ppm MN (M) 0.005 ppm MN (M) 0.005 ppm MN (M) 0.003 ppm MN (M) 0.010 ppm MN (M) 0.0100 ppm MN (M) 0.010000000000000000000000000000000000			-TO	1.0	mdd	325.2
Per (1)			CO3	2.0	ppm CaCO3	310.1
HEE(D) 0.010 ppm HARD 5.0 ppm CaCO3    HCO3 2.0 ppm CaCO3    MM (D) 0.005 ppm MM			(a) no	0.001	bbw	6020
HARD HCO3 E.0 Ppm RC RC C.0 Ppm MG MA D.0 Dpm NA NA D.0 Dpm PB(D) SOA = 2.0 Ppm PB(D) SOA = 2.0 Ppm CL			FE(D)	0.010	mdd	6010E
K         2.0         ppm           M         C         0.005         ppm           MN (D)         0.005         ppm           NM (D)         0.050         ppm           NM2/N3         0.050         ppm           PB (D)         0.003         ppm           PB (D)         0.003         ppm           SG (D)         0.003         ppm           SG (D)         0.010         ppm           SG (D)         0.010         ppm           AS (D)         104         \$Recovery         MX         23-APR-03           CL-         100         \$Recovery         MX         23-APR-03           CL-         101         \$Recovery         MX         23-APR-03           MG         SR-4XSA         \$			HARD	5.0	mdd	6010E
K         2.0         ppm           MG         1.0         ppm           MM(D)         0.005         ppm           NAA         2.0         ppm           NAB/N         0.050         ppm           PB(D)         0.003         ppm           SG4=         2.0         ppm           AS(D)         0.10         ppm           AS(D)         10.1         \$Recovery         MK         23-APR-03           CL-         100         \$Recovery         MK         23-APR-03           CL         101         \$Recovery         MK         23-APR-03           MG         SR-4XSA			HCO3	2.0	ppm CaCO3	310.1
NG   1.0   ppm			M	2.0	mdd	6010E
NA			MG	1.0	mdd	60108
NAA         2.0         ppm           NH3/N         0.050         ppm           NOZ/NO3         0.050         ppm           SB(D)         0.003         ppm           SO4=         2.0         ppm           SO4=         2.0         ppm           TDS         10.         ppm           ZN(D)         0.010         ppm           ZN(D)         104         \$Recovery         MK         28-APR-03           CL-         100         \$Recovery         MK         23-APR-03           CL-         101         \$Recovery         MK         23-APR-03           MG         SR-4XSA         \$Recovery         MK         23-APR-03           NA         NA         SP-4XSA         \$Recovery         MC         23-APR-03           NA         99         \$Recovery         MR         23-APR-03           NA         98         \$Recovery         MR         23-APR-03			MN(D)	0.005	mdd	6010E
NH3/N			NA	2.0	mdd	60101
PB(D)			NH3/N	0.050	mdd	350.1
PB(D)			NO2/NO3	0.050	mdd	353.2
SB(D)			PB(D)	0.003	mdd	6020
SO4 = 2.0   ppm			SB(D)	0.003	mdd	6020
TDS			SI-SI02	0.10	mdd	60101
TDS 10. ppm  AS(D) 104 \$RECOVETY MK 28-APR-03  CA SR-4XSA \$RECOVETY MK 23-APR-03  CL- 100 \$RECOVETY MK 23-APR-03  CU(D) 101 \$RECOVETY MK 23-APR-03  FE(D) 101 \$RECOVETY MK 24-APR-03  K 87 \$RECOVETY MK 23-APR-03  MM D) 99 \$RECOVETY MK 23-APR-03  MM S SR-4XSA \$RECOVETY MK 23-APR-03  MM D) 98 \$RECOVETY MK 29-APR-03  SR(D) 98 \$RECOVETY MK 28-APR-03  SR(D) 98 \$RECOVETY MK 28-APR-03  SR(D) 98 \$RECOVETY MK 28-APR-03			SO4=	2.0	mdd	9036
AS(D)   0.010   ppm			TDS	10.	mdd	160.
AS(D) 104 \$Recovery MK 28-ARR-03  CL- 100 \$R-AXSA \$Recovery MK 23-APR-03  CU(D) 101 \$Recovery MK 23-APR-03  FR(D) 101 \$Recovery MK 23-APR-03  K 87			ZN(D)	0.010	mdd	6020
SR-4XSA	Matrix Spi	ke	AS(D)	104		
100   \$Recovery JN   13-MAY-03			45	SR>4XSA		
101 \$Recovery MK 20-APR-03 101 \$Recovery MK 23-APR-03 87 \$Recovery MK 23-APR-03 99 \$Recovery MK 23-APR-03 98 \$Recovery MK 29-APR-03 100 \$Recovery MK 29-APR-03 100 \$Recovery MK 29-APR-03			-TJ	100		
101 \$Recovery MK 23-APR-03 87 \$Recovery MK 23-APR-03 99 \$Recovery MK 23-APR-03 99 \$Recovery MK 23-APR-03 88>4XSA \$Recovery MK 23-APR-03 99 \$Recovery JN 29-APR-03 99 \$Recovery JN 29-APR-03 100 \$Recovery MK 29-APR-03			CO(D)	101		
SR>4XSA			FE(D)	101		
SR-4XSA			Ж	87		
99 \$Recovery MK 23-APR-03 SR>4XSA \$Recovery MK 23-APR-03 99 \$Recovery JN 29-APR-03 98 \$Recovery MK 28-APR-03 100 \$Recovery MK 28-APR-03			MG	SR>4XSA		
SR>4XSA			MN(D)	66		
99 \$Recovery JN 29-APR-03 98 \$Recovery JN 01-MAY-03 99 \$Recovery MK 28-APR-03 100 \$Recovery MK 28-APR-03			NA	SR>4XSA		
33 98			NH3/N	66		
98			NO2/NO3	98		
100 RRecovery MK 28-APR-03			PB (D)	98		
			SB(D)	100		

AMERICAN ENVIRONMENTAL CONSULTANTS

ANALYTICAL DATA REPORT

GENESIS INC.

(Project TROY MINE)

Batch No: WG030177

DATE ANALYZED METHOD	23-APR-03 9036		30-APR-03 310.1	28-APR-03 6020	23-APR-03 6010B	13-MAY-03 325.2	30-APR-03 310.1		23-APR-03 6010B	23-APR-03 6010B	30-APR-03 310.1						01-MAY-03 353.2				23-APR-03 9036	22-APR-03 160.1	28-APR-03 6020	30-APR-03 310.1					23-APR-03 6010B	30-APR-03 310.1	24-APR-03 6010B	23-APR-03 6010B	23-APR-03 6010B	23-APR-03 6010B	29-APR-03 350.1		28-APR-03 6020
ANALKST	NE	MK	EH	MK	MK	J.N.	EH	MK	MK	MK	EH	MK	MK	MK	MK	N <sub>2</sub>	JN	MK	MK	MK	CN	BD	MK	EH	MK	MK	UN	MK	MK	EH	MK	MK	MK	MK	UN	N.S	MK
UNITS	Recovery	*Recovery	ppm CaCO3	wdd	mdd	mdd	ppm CaCO3	wdd	mdd	mdd	ppm CaCO3	mdd	wdd	mdd	mdd	mdd	mdd	шdd	mdd	mdd	mdd	mdd	mdd	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery	*Recovery
VALUE	93	102	<2.0	<0.003	<1.0	<1.0	<2.0	<0.001	<0.010	<5.0	<2.0	<2.0	<1.0	<0.00>	<2.0	<0.050	<0.050	<0.003	<0.003	<0.10	<2.0	<10.	<0.010	104	103	101	105	105	66	104	102	66	66	102	101	96	106
PARAMETER	OS III	ZN(D)	ALK.	AS(D)	S	-13	5003	(a) no	FE(D)	HARD	HCO3	M	MG	MN (D)	NA	NH3/N	NO2/NO3	PB(D)	SB(D)	SI-SI02	SO4=	TDS	ZN(D)	ALK.	AS(D)	5	-TJ	CU(D)	FE(D)	нсоз	Ж	MG	MN (D)	NA	NH3/N	NO2/NO3	PB(D)
DESCRIPTION	Matrix Spike		Prep Blank																					Lab Control Sample													
DATE																																					
LAB NO	WG030177-7		WG030177-8																					WG030177-9													

ANALYTICAL DATA REPORT

GENESIS INC.

(Project TROY MINE)

Batch No: WG030177

МЕТНОБ		6010B	9036	160.1	6020	310.1	325.2	310.1	310.1	350.1	353.2	9036	160.1	0000	6010B	6020	6010B	6010B	6010B	6010B	6010B	6020	6020	6010B	6020
DATE		23-APR-03 6010B	23-APR-03 9036	22-APR-03	28-APR-03	30-APR-03 310.1	13-MAY-03	29-APR-03	30-APR-03	29-APR-03 350.	01-MAY-03 353.2	23-APR-03 9036	22-APR-03 160.1	08-ADB-03 6020	23-APR-03			24-APR-03	23-APR-03	23-APR-03	23-APR-03				28-APR-03
ALYST	MIC	MK	- NO	BD	MK	EH	JN	EH	EH	NS	N	JN	BD	MK	MIK	MK	MK	MK	MK	MK	MK	MK	MK	MK	MIK
DATE UNITS ANALYZED METHOD	Recovery	*Recovery	*Recovery	*Recovery	*Recovery	* RPD	% RPD	% RPD			% RPD		* RPD	& RPD	\$ RPD	% RPD	% RPD				& RPD	* RPD		& RPD	\$ RPD
VALUE	101	104	105	101	103	1.5	+/-prdl	<1	1.5	+/-brdl	2.4	8.7	5.6		<1	41	4	5.2	41	41	41	1.0	2.0	41	<1
PARAMETER	SB(D)	SI-SI02	S04=	TDS	ZN(D)	ALK.	-17	003	нсоз	NH3/N	NO2/NO3	S04=	TDS	AS (D)	5	CA (D)	FE(D)	К	MG	MN (D)	NA	PB(D)	SB(D)	SI-S102	ZN(D)
						,																			
DATE COLLECTED DESCRIPTION	Lab Control Sample					Duplicate								Matrix Spike Duplicate											
DATE LAB NO COLLECTED	WG030177-9					WG030177-10								WG030177-11											

Unless otherwise noted results are not blank corrected.

DI ANTI INFORMATION		Enviro	Environmental		
TEAN INFORMATION		I. HEPOHI IN:	II. KEPUKI INSTRUCTIONS	SEND REGUESTS 10:	10:
ant Requesting Service: TROY MINE		Additional Cop	45	TSC LABORATORY	ORY
roject Description: TROY MINE WATER		services Requested below are Requested No Later Tha	are Requested below 13/ Highland Ave.	Salt Lake City, Utah	west Utah
our Project No.:					6
amples Collected By:		Please Forward Results by:	Results by: USMail * Hed EX () Fax () Other (6)	Your Customer Service	rvice
TYPE OF SERVICE REQUESTED:				Jodie Haynes	
Please send the following supplies: ( ) Sampling media or containers	Please Specify	Ŋ	GENESIS INC. P.O. BOX 1660	Phone no: (801) 263-5256	3-5256
( ) Laboratory services forms	( ) Other		TROY, MT 59935		
Please analyze the enclosed samples for:	for:				Laboratory
Sampling sample I.D./Description/Tag No.	n/Tag No.	No. of Containers	Analyses Requested	Comments	Use Only Lab. No.
4/15/03 8:26am S. O. B.		3	** See Table 2 Water Quality	Samples for	
4/15/03 9:24 am Decant Pond	2-	3	Analytical Parameters.	metals were	
4/15/03 9:35am North Toe Pond	-3	3	** Filtered samples were preserved	preserved with	
4/15/03 3:50pm SC-15	-4	e e	with 5 ml. HNO,	5 ml. HNO.	
4/15/03 10:31am SC-17-A	1.5	3	ſ	Samples for	
4/15/03 10:17am SC-2	9-	3		NO2/NO3 were	
4/15/03 10:25am FC-1	74	3		preserved with	
4/15/03 2:40pm LC-4 CHAIN OF CUSTODY RECORD	00	3		2 ml. H <sub>2</sub> SO <sub>4</sub> .	
ertent: the Signatures Below The Point					
spaiched By: Buy Clark	Date 4/17/03	Time /2,30,000	Time 12 120 Au Courier Company Name: UPS (Feed 54	Shipping Airbill#	Castody Scal Intact
linquished By:	Date	Time	Received By: Date	Time	Yes NA
linquished By:	Dec	Тіве	M. S. Limber Date 4/18/03	IIme 11: 00 AM	°Z,

			Laboratory S Enviro	Laboratory Services Request Form Environmental			*
PLANT INFORMATION	ATION		II. REPORT INSTRUCTIONS	STRUCTIONS		SEND REQUESTS TO:	TO:
lant Requesting Service:	Service: TROY MINE		Orginal Report	Orginal Report To: BRUCE CLARK MINE MANAGER Additional Conv Of Report To: 101 Vot Octav		ASARCO TSC LABOBATORY	\ <u>0</u>
erson Requesting	erson Requesting Service: BRUCE CLARK	LARK	Services Requested Below	ested Below 157 Highland Ave		3422 South 700 West	West
olir Project No .	oject Description: TROY MINE WATER		are Requested	are Requested No Later Than. Orchard Park, NY	14127	Salt Lake City, Utah	Utah
amples Collected By:	By:		Please Forward Results by:	US Mail **	Date Fed EX () Fax () Others(6)	84119 Your Customer Service	9 irvice
. TYPE OF SERV	TYPE OF SERVICE REQUESTED:					Representative is: Jodie Haynes	
Please send th ( ) Sampling	Please send the following supplies: ( ) Sampling media or containers	es: s Please Specify	ľy			Phone no: (801) 263-5256	3-5256
( ) Laborator	( ) Laboratory services forms	( ) Other					*
Please analyze	Please analyze the enclosed samples for	ples for:					Laboratory
sampling ate & Time	Sample I.D./Description/Tag No.	iption/Tag No.	No. of Containers	Analyses Requested		Comments	Use Only Lab. No.
/15/03 9:47am	EP-1	6-	3	** See Table 2 Water Quality		Samples for	
/16/03 5:22pm	IW-1	01-	3	Analytical Parameters.		metals were	
/16/03 3:55pm	MW-1	-11	3	** Filtered samples were preserved	Sprived	nrocorno daith	
/16/03 9:30am	MW-2	-12	3	with 5 ml. HNO.		5 ml HNO	
/16/03 2:00pm	MW-3	-13	3	n		Samples for	
/16/03 11:15am	MW-4	41-	3			NO2/NO3 were	
/16/03 10:25am	TRMW 95-3	VI	3			preserved with	
/16/03 10:40am	6/03 10:40am TRMW 95-4	-16	3			2 ml. H <sub>2</sub> SO <sub>4</sub> .	
ortent: Ue Signur en Befow The Point	Da						
spatched By: Thurs	. Clark	Date 4/17/08	Time /2 : 8 upm	Time 12, 2000 Courier Company Name: UB Fed S	X	Shipping Airbill#	Custody Scal Intact
linquished By:		Date	Тіве	Received By: Date		Time	Yes NA
linouished By:				maken Male	w les		

ý.

REQUEST: Quality Assurance & Quality Control

PLANT INFORMATION lant Requesting Service: TROY MINE erson Requesting Service: BRUCE CLARK roject Description: TROY MINE WATER our Project No.: amples Collected By:			Environmental			
lant Requesting Service: TROY MINE erson Requesting Service: BRUCE CLARK roject Description:TROY MINE WATER our Project No.: amples Collected By:		I. REPORT INS	II. REPORT INSTRUCTIONS		SEND REQUESTS TO:	TO:
roject Description:TROY MINE WATER our Project No.: amples Collected By:		Orginal Report To: BRUCE CI Additional Copy Of Report	30	K MINE MANAGER  10E VOLOSIN 157 Highland Ave	ASARCO TSC LABORATORY	)RY West
amples Collected By:		are Requested	an	Park, NY 14127	Salt Lake City, Utah	Utah
1. TYPE OF SERVICE REQUESTED:		Please Forward Results by:		US Mail () Fax () Cheggs	Your Customer Service	rvice
					Representative is: Jodie Haynes	
Please send the following supplies: ( ) Sampling media or containers Plea	Please Specify	ry .			Phone no: (801) 263-5258	3-5256
( ) Laboratory services forms ( )	) Other					
Please analyze the enclosed samples for:		o N				Laboratory
ate & Time Sample I.D./Description/Tag No.	rag No.	Containers	Requested	ed	Comments	Lab. No.
1/15/03 1:50pm L.C-2	#	3	** See Table 2 Water	2 Water Quality	Samples for	
1/15/03 10:06am LC-1	8	3	Analytical Parameters.	rs.	metals were	
			** Filtered samples were preserved	were preserved	preserved with	
			with 5 ml. HNO <sub>3</sub>		5 ml. HNO3.	
					Samples for NO <sub>2</sub> /NO <sub>3 were</sub>	
					preserved with	
CUAIN OF CHETONY DECORD					2 ml. H <sub>2</sub> SO <sub>4</sub> .	
petial: the Signature Billow This Point						
spatched By: Bull Cloude Dates	4/11/03	Time (2: 50. pm	Time (21 30 pm Courier Company Name: UPS	(Fed 5k.	Shipping Airbill#	Custody Scal Intact
·finquished By:		Time	Received By:	Date	Time	Yes M
· · · · · · · · · · · · · · · · · · ·		Time	Received for Lab By:	Date 4/18/03	Time II:00	No

# Technical Services Center

Laboratory Services Request Form Environmental

DI ANIT THE PROPERTY.			EIIVILO	Environmental			4
PLAN INFORMATION	NOIL		II. REPORT INSTRUCTIONS	STRUCTIONS		SEND DEDITEOR	- CH
			Orginal Report	Torming of the		SEND REQUESTS TO:	:0:
lant Requesting Se	lant Requesting Service: TROY MINE		Additional Cop	Additional Copy Of Report To: JOE VOLOSIN	ANAGER	TSC LABORATORY	) BY
roject Description: TROY MINF WATER	roject Description TROY MINE WATER		Services Requested Below	ested Below 157 High	157 Highland Ave.	3422 South 700 West	West
our Project No.:	WITH HITTER		are Hequested	are Hequested No Later Than. Orchard Park, NY 14127	Park, NY 14127	Salt Lake City, Utah	Utah
amples Collected By:	3y:		Please Forward Results by:		Date US Mail ★ Red EX () Pax () Other K(4)	84119 Your Customer Service	9 rvice
I. TYPE OF SERVIC	TYPE OF SERVICE REQUESTED:					Representative is: Jodie Haynes	
Please send the ( ) Sampling n	Please send the following supplies: ( ) Sampling media or containers	Please Specify	>			Phone no: (801) 263-5256	3-5256
( ) Laboratory	( ) Laboratory services forms	( ) Other					
Please analyze th	Please analyze the enclosed samples for:	for:	A				
Sampling late & Time Sa	Sample I.D./Description/Tag No.	n/Tag No.	No. of Containers	Analyses			Use Only
/16/03 10:55am	TRMW 95-5	61-	3	** See Table 2 Water Ouality	Ouality	Comments Comments	Lab. No.
/16/03 11:00am	TRMW 97-12	-20	3	Analytical Parameters.		motals more	
/16/03 10:00am	TRMW 97-14	- 21	3	44 1011		mergro were	
/15/03 8:12am	Service Adit-P (7	East) - 7 1	3 ,	fillered Samples were preserved	ere preserved	preserved with	
/15/03 7:52am	Service Adit-D	- 23	3	WILL JULY HAD		5 ml. HNO <sub>3</sub> .	
/15/03 8:00am	Transfer Point	-24	3			NO,/NO,	
/15/03 8:18am	9 East	-25	3			2 3 Were	
/15/03 8:36am	UQ-1	- 26	3			2 ml H SO	
7. CHAIN OF CUSTODY RECORD	ODY RECORD						
ispatched By: 72,000	Cash "	20/1///porec	Time / 2,30 m	Time / 2, 3d Mr. Contier Company Name: UDS	Fed 1x	Shipping Airbill#	Castody Seal Jaho
elinquished By:	Q	Date	Time		Date	au.	
clinquished By:	G	Date	Тіве	Received for Lab By:	Date 4/18 /03	11.00 444	44
omioad .	mountour				1	441	O. H

REQUEST: Quality Assurance & Quality Control

Pola .... 1. 1. 200, 000, 0. 1. h. MALL



### AMERICAN ENVIRONMENTAL CONSULTANTS LABORATORY

3422 South 700 West Salt Lake City, Utah 84119-4191

- (801) 261-1426 • FAX (801) 264-9838

June 11, 2003



Mr. Bruce Clark
TROY UNIT

Please find attached the analytical results and quality control data for two water samples collected for the **TROY Mine Water** project on May 06, 2003. The laboratory received the samples on May 08, 2003.

The test results meet the requirements of the National Environmental Laboratory Accreditation Conference, in accordance with Chapter 5 of the 1999 NELAC Standard.

If you have any question, I can be reached at (801) 262-2459.

Sincerely,

Bilquis Dhedhy

Chemist

GENESIS INC.

(Project )

Batch No: L030197

7-001 06-MAY-03 08:55 MW-15-01  A.M.K. A6 (D)  CA (D)	DATE/TIME	111111111111111111111111111111111111111			DATE
ALK. A6 (D) 6003 EH 09-6MY-03  CA(D) 14. ppm MK 21-MAY-03  CA(D) 6.004 ppm MK 21-MAY-03  FE(D) 6.004 ppm MK 21-MAY-03  FE(D) 6.004 ppm MK 21-MAY-03  FE(D) 6.004 ppm MK 21-MAY-03  K(D) 47. ppm CaCO3 EH 09-MAY-03  K(D) 3.3 ppm CACO3 EH 09-MAY-03  MA(D) 2.4 ppm MK 21-MAY-03  MA(D) 2.4 ppm MK 21-MAY-03  MA(D) 6.035 ppm MK 21-MAY-03  FE(D) 6.003 ppm MK 21-MAY-03  FE(D) 6.003 ppm MK 21-MAY-03  S1-S102 9.7 ppm MK 21-MAY-03  CA(D) 6.003 ppm MK 21-MAY-03  S1-S102 9.7 ppm MK 21-MAY-03  CA(D) 6.003 ppm MK 21-MAY-03  CA(D) 6.004 ppm MK 21-MAY-03  MA(D) 6.1 ppm MK	LAB NO COLLECTED DESCRIPTION	Parameter	VALUE	UNITS ANALYST	ANALYZED METHOD
Λ.Κ.         47.         ppm         CACO3         EH         99-KMY-03           CΛ.(D)         14.         ppm         KR         23-kMY-03           CΛ.(D)         42.0         ppm         KR         23-kMY-03           COJ         42.0         ppm         KR         21-kMY-03           FE(D)         40.004         ppm         KR         21-kMY-03           FE(D)         47.         ppm         KR         21-kMY-03           K(D)         40.03         ppm         KR         21-kMY-03           K(D)         40.03         ppm         KR         21-kMY-03           K(D)         40.03         ppm         KR         21-kMY-03           SSA         4         ppm         KR         21-kMY-03           SSA         4         ppm         KR         21-kMY-03           SSA         4 <td< td=""><td></td><td></td><td></td><td></td><td></td></td<>					
ΛS (D)         < 0.003         ppm         NK         23-νΑΥ-0           CL-         1.1         ppm         MK         23-νΑΥ-0           CL-         2.0         ppm         MK         21-νΑΥ-0           CL-         0.004         ppm         MK         21-νΑΥ-0           CUD         0.004         ppm         MK         21-νΑΥ-0           HCO3         47.         ppm         MK         21-νΑΥ-0           HCO3         47.         ppm         MK         21-νΑΥ-0           MG(D)         47.         ppm         MK         21-νΑΥ-0           MG(D)         2.4         ppm         MK         21-νΑΥ-0           MG(D)         2.4         ppm         MK         21-νΑΥ-0           MG(D)         2.4         ppm         MK         21-νΑΥ-0           MG(D)         0.35         ppm         MK         21-νΑΥ-0           MG(D)         0.02         ppm         MK<	L030197-001 06-MAY-03 08:55 MW-15-01	ALK.	47.	CaCO3	
C(1) 14, ppm CaCO3 EH 21-40-40-70 CO3		, AS(D)	<0.003		
CL-         1.1         ppm         CACOD         11         14-MAY-0           CU(D)         6.004         ppm         CACOD         HR         14-MAY-0           FE(D)         6.004         ppm         MK         21-MAY-0           FE(D)         6.004         ppm         MK         21-MAY-0           HACO3         43.         ppm         MK         21-MAY-0           K(D)         43.         ppm         MK         21-MAY-0           MK(D)         43.         ppm         MK         21-MAY-0           MK(D)         40.05         ppm         MK         21-MAY-0           MK(D)         2.4         ppm         MK         21-MAY-0           MK(D)         40.05         ppm         MK         21-MAY-0           MK(D)         40.002         ppm         MK         21-MAY-0           MK(D)         6.3         ppm         MK         21-MAY-0           MK(D)         6.3         ppm         MK         21-MAY-0           SS4         2         ppm         MK         21-MAY-0           SY4         2         ppm         MK         21-MAY-0           SY4         2 <td></td> <td>CA(D)</td> <td>14.</td> <td></td> <td>15</td>		CA(D)	14.		15
CO3 6.2.0 ppm CaCO3 EH 09-MAY-0  CU (D) 6.004 ppm MK 21-MAY-0  HARD 4. ppm MK 21-MAY-03  HARD 4. ppm CaCO3 EH 02-MAY-03  HARD 4. ppm CaCO3 EH 02-MAY-03  MK (D) 6.005 ppm MK 21-MAY-03  MK (D) 3.3 ppm MK 21-MAY-03  MK (D) 6.35 ppm MK 21-MAY-03  PM (D) 0.35 ppm MK 21-MAY-03  PM (D) 0.35 ppm MK 21-MAY-03  PM (D) 6.30 ppm MK 21-MAY-03  S1-S10 c0.03 ppm MK 21-MAY-03  S1-S10 c0.03 ppm MK 28-MAY-03  S1-S10 c0.03 ppm MK 28-MAY-03  S1-S10 c0.03 ppm MK 28-MAY-03  ALK. 27. c0.003 ppm MK 28-MAY-03  ALK. 27. c0.003 ppm MK 28-MAY-03  CC (D) 6.00 ppm MK 21-MAY-03  CC (D) 6.00 ppm MK 21		Ė	1.1		
CU(D)         0.004         ppm         MK         21-MAY-03           HARD         49.         ppm         MK         21-MAY-03           HOO3         49.         ppm         MK         21-MAY-03           HOO4         49.         ppm         MK         21-MAY-03           HOO4         2.4         ppm         MK         21-MAY-03           HOO4         2.4         ppm         MK         21-MAY-03           HOO4         2.4         ppm         MK         21-MAY-03           HOO4         4.0         0.35         ppm         MK         21-MAY-03           SB(D)         4.0         0.35         ppm         MK         21-MAY-03           SB(D)         4.0         ppm         MK         21-MAY-03           SB(D)         4.0         ppm         MK         21-MAY-03           SB(D)         4.0         ppm         MK         21-MAY-03           ALL         5		003	<2.0	CaC03	
HARD   47.   Ppm   MK   21-MAY-0.		. CA(D)	0.004		
HOND   HOND   HOND   HOND   HOND   HOND		FE(D)	<0.010		
He color		HARD	49.		
MG(D)         42.0         ppm         MK         21-MAX-03           MN(D)         42.0         ppm         MK         21-MAX-03           MN(D)         40.005         ppm         MK         21-MAX-03           NH3/N         0.35         ppm         MK         21-MAX-03           NM2/NO3         0.35         ppm         MK         21-MAX-03           PH         6.35         ppm         MK         12-MAX-03           PH         6.35         ppm         MK         12-MAX-03           SO4=         5.3         ppm         MK         28-MAX-03           SO4=         5.0         ppm         MK         28-MAX-03           SO4=         25.         ppm         MK         28-MAX-03           SO4=         25.         ppm         MK         28-MAX-03           ALK         27.         ppm         MK         28-MAX-03           ALK         27.         ppm         MK         28-MAX-03           ALK         27.         ppm         MK         21-MAX-03           CL-         40.0         ppm         MX         21-MAX-03           CL-         40.0         ppm		HCO3	47.	CaCO3	
MM(D)		K(D)	<2.0		
MN (D)		MG(D)	3.3		
NA(D)         2.4         ppm         MK         21-MAY-03           NA2/N3         0.28         ppm         JM         12-MAY-03           NA2/N3         0.35         ppm         JM         16-MAY-03           PH         (0.002         ppm         MK         28-MAY-03           SI-SIO2         9.7         ppm         MK         28-MAY-03           SO4=         25.         ppm         MK         28-MAY-03           SO4=         25.         ppm         MK         28-MAY-03           SO4=         25.         ppm         MK         28-MAY-03           ZN (D)         <0.010		MN(D)	<0.005		
NH3/N		NA(D)	2.4		
NO2/NO3		N/EHN	0.28		
PB (D)         < 0.002         ppm         MK         28-MXY-03           SB (D)         < 0.003         ppm         MK         28-MXY-03           SD (A)         < 0.003         ppm         MK         28-MXY-03           SO (A)         < 25.         ppm         MK         06-JUN-03           SO (A)         < 0.010         ppm         MK         28-MXY-03           ZN (D)         < 0.010         ppm         MK         28-MXY-03           ALK,         27.         ppm         MK         28-MXY-03           CA (D)         < 0.010         ppm         MK         28-MXY-03           CA (D)         < 0.048         ppm         MK         21-MXY-03           CA (D)         < 0.048         ppm         MK         21-MXY-03           FE (D)         < 0.048         ppm         MK         21-MXY-03           FE (D)         < 0.048         ppm         MK         21-MXY-03           HACA3         < 0.048         ppm         MK         21-MXY-03           M (D)         < 0.048         ppm         MK         21-MXY-03           MA (D)         < 0.05         ppm         MK         21-MXY-03		NO2/NO3	0.35		
PH         6.3         pH         EH         09-MAY-03           SB (D)         < 0,003		PB(D)	<0.002		
SB(D)		hd	6.3		
St. S102   9.7   ppm   MK   06-JUN-03		SB(D)	<0.003	TE	11/7/
TDS		SI-5102	9.7		
TDS 112. Ppm BD 09-MAY-03		SO4=	25.		
ZN(D)         <0.010         ppm         MK         28-MAY-03           AS(D)         <0.003		TDS	112.		
AS(P)		ZN(D)	<0.010		
ALK. 27. Ppm CaCO3 EH 09-MAY-03 CA(D) 13. Ppm CaCO3 EH 09-MAY-03 CC3 < 2.0 Ppm MK 21-MAY-03 CO3 < 2.0 Ppm AMK 21-MAY-03 CU(D) 0.048 Ppm MK 21-MAY-03 PE(D) 0.048 Ppm MK 21-MAY-03 PE(D) 0.049 Ppm MK 21-MAY-03 HARD 43. Ppm MK 21-MAY-03 HCO3 27. Ppm AMK 21-MAY-03 MCD) 2.5 Ppm MK 21-MAY-03 MN(D) 0.14 Ppm MK 21-MAY-03 NA3/N 0.15 Ppm MK 21-MAY-03 NA3/N 0.015 Ppm MK 21-MAY-03 PB(D) 0.002 Ppm MK 22-MAY-03 MN 22-MAY-03 MN(D) 0.24 Ppm MK 21-MAY-03 NA3/N 0.015 Ppm MK 21-MAY-03 NA3/N 0.015 Ppm MK 22-MAY-03 PB(D) 0.002 Ppm MK 22-MAY-03	CHANGE MICROSCHE AND ON CO. MANS TO COO FOLIACA TO				
13.   13.	LUSUIS/-UUZ US-MAI-US US:UU DECANI FOND	Auk.	.17	Cacos	
13.   Ppm   MK   21-MAY-03		AS(D)	<0.003		
1.0   Ppm   JN   14-MX-03		CA(D)	13.		
1.00   1.00		-13	<1.0		
0.048 Pypm MK 28-MyY-03 43. Pypm MK 21-MyY-03 43. Pypm MK 21-MyY-03 27. Pypm CaCO3 EH 09-May-03 <25. Pypm MK 21-MyY-03 0.14 Pypm MK 21-MyY-03 0.14 Pypm MK 21-MyY-03 0.14 Pypm MK 21-MyY-03 0.15 Pypm MK 21-MyY-03 0.16 Pypm MK 21-MyY-03 0.11 Pypm MK 21-MyY-03 0.050 Pypm MK 21-MyY-03 0.050 Pypm MK 21-MyY-03 0.050 Pypm MK 22-MyY-03 0.050 Pypm MK 22-MyY-03 0.050 Pypm MK 22-MyY-03		003	<2.0	CaC03	
40,010   ppm   MK   21-MAY-03     43.   ppm   MK   21-MAY-03     27.   ppm   CaCO3   EH   09-MAY-03     28.5   ppm   MK   21-MAY-03     28.5   ppm   MK   21-MAY-03     28.5   ppm   MK   21-MAY-03     29.5   ppm   MK   21-MAY-03     29.5   ppm   MK   21-MAY-03     29.5   ppm   JM   12-MAY-03     20.050   ppm   JM   12-MAY-03     20.002   ppm   MK   20-MAY-03     20.002   ppm   MK   20-MAX-03     20.002   ppm		(a) (a)	0.048		
43. ppm AK 21-MAY-03 27. ppm CaCO3 EH 09-MX-03 2.5 ppm MK 21-MAY-03 0.14 ppm MK 21-MAY-03 1.6 ppm MK 21-MAY-03 0.11 ppm MK 21-MAY-03 0.11 ppm JM 21-MAY-03 0.002 ppm MK 21-MAY-03 0.10 ppm JM 21-MAY-03 0.002 ppm MK 21-MAY-03		FE(D)	<0.010		
27. ppm CaCO3 EH 09-MAY-03 2.5 ppm MK 21-MAY-03 0.14 ppm MK 21-MAY-03 1.6 ppm MK 21-MAY-03 0.11 ppm JM 21-MAY-03 0.11 ppm JM 21-MAY-03 0.002 ppm JM 22-MAY-03 0.002 ppm JM 52-MAY-03		HARD	43.		
<ul> <li>&lt;2.0</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>0.14</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>0.11</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>0.11</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>0.13</li> <li>ppm</li> <li>MY</li> <li>12-MAY-03</li> <li>&lt;0.050</li> <li>ppm</li> <li>MY</li> <li>12-MAY-03</li> <li>&lt;0.050</li> <li>ppm</li> <li>MK</li> <li>21-MAY-03</li> <li>&lt;0.050</li> <li>ppm</li> <li>MK</li> <li>22-MAY-03</li> <li>&lt;0.002</li> <li>ppm</li> <li>MK</li> <li>22-MAY-03</li> </ul>		HCO3	27.	CaC03	
2.5 ppm MK . 21-MAY-03 0.14 ppm MK 21-MAY-03 1.6 ppm MK 21-MAY-03 0.11 ppm JN 12-MAY-03 3 <0.050 ppm JN 16-MAY-03 <0.002 ppm MK 28-MAY-03		K(D)	<2.0		
0.14 ppm MK 21-MAY-03 1.6 ppm MK 21-MAY-03 0.11 ppm JN 12-MAY-03 33 <0.050 ppm JM 16-MY-03 <0.002 ppm MK 28-MAY-03		(C) DW	2.5	457	
1.6 ppm MK 21-MAY-03 0.11 ppm JN 22-MAY-03 3 <0.050 ppm JN 16-MAY-03 <0.002 ppm MK 28-MAY-03		MN (D)	0.14		
0.11 ppm JN 12-MAY-03 03 <0.050 ppm JN 16-MAY-03 <0.002 ppm MK 28-MAY-03		NA(D)	1.6		
03 <0.050 ppm JN 16-MAY-03 <0.002 ppm MK 28-MAY-03		NH3/N	0.11		
<0.002 ppm MK 28-MAY-03		NO2/NO3	<0.050		
		PB(D)	<0.002		

ANALYTICAL DATA REPORT

GENESIS INC.

(Project )

Batch No: L030197

DATE ANALYZED METHOD	09-MAY-03 150.1 28-MAY-03 6020 06-JUN-03 6010B 08-MAY-03 9036 09-MAY-03 160.1 28-MAY-03 6020
UNITE ANALKSI	# # # # # B #
UNITS	Hqq mqqq mqqq mqqq
WALUE	6.3 <0.003 9.1 25. 84.
PARAMETER	PH SB(D) S1-SIO2 SO4 = TDS ZN(D)
LAB NO COLLECTED DESCRIPTION	L010197-002 06-MAY-03 09:00 DECANT POND

Unless otherwise noted results are not blank corrected. NP = Collect time Not Provided.

Page 3 of 6

ANALYTICAL DATA REPORT

GENESIS INC.

(Project )

Batch No: WG030223

QC Matrix Spike

WG030223-1

DATE/FIME DESCRIPTION

LAB NO

AS(D) 1102 \$Recovery MK 28-M CL- 107 \$Recovery MK 21-M CU(D) 99 \$Recovery MK 21-M K(D) 95 \$Recovery MK 21-M MG(D) 93 \$Recovery MK 21-M ND2/NO3 93 \$Recovery MK 28-M ND2/NO3 93 \$Recovery MK 28-M SI-SIO2 93 \$Recovery MK 28-M SI-SIO2 93 \$Recovery MK 28-M SI-SIO2 93 \$Recovery MK 28-M CA(D) 96 \$Recovery MK 28-M SI-SIO2 93 \$Recovery MK 28-M CA(D) 96 \$Recovery MK 28-M CA(D) 96 \$Recovery MK 28-M CA(D) 97 \$Recovery MK 28-M CA(D) \$0.003 \$Recovery MK 28-M CA(D) \$0.003 \$Recovery MK 21-M CA(D) \$0.003 \$Recovery MK 21-M CA(D) \$0.001 \$ppm \$MK 21-M CA(D) \$0.001 \$ppm \$MK 21-M CA(D) \$0.001 \$ppm \$MK 21-M CA(D) \$0.002 \$ppm \$MK 21-M CA(D) \$0.003 \$ppm \$MK 21-M CA(D) \$0.002 \$ppm \$MK 21-M CA(D) \$0.003 \$ppm \$MK 21	28-MAY-03 6020.	21-MAY-03 6010B	14-MAY-03 325.2	28-MAY-03 6020	21-MAY-03 6010B	21-MAY-03 6010B	21-MAY-03 6010B	21-MAY-03 6010B		12-MAY-03 350.1	16-MAY-03 353.2	28-MAY-03 6020	28-MAY-03 6020	06-JUN-03 6010B	08-MAY-03 9036		09-MAY-03 310.1	28-MAY-03 6020	21-MAY-03 6010B	14-MAY-03 325.2	09-MAY-03 310.1	28-MAY-03 6020	21-MAY-03 6010B	21-MAY-03 2340B	09-MAY-03 310.1	21-MAY-03 6010B	21-MAY-03 6010B	21-MAY-03 6010B	21-MAY-03 6010B	12-MAY-03 350.1	16-MAY-03 353.2	28-MAY-03 6020	28-MAY-03 6020	06-JUN-03 6010B	08-MAY-03 9036	39-MAY-03 160.1
102  \$R>4XSA \$RECOVETY 107  \$RCOVETY 99 \$RECOVETY 99 \$RECOVETY 95 \$RECOVETY 8RECOVETY 8RECOVETY 117 \$RECOVETY 98 \$RECOVETY 98 \$RECOVETY 96 \$RECOVETY 97 \$RECOVETY	***	21-M		200													™-60			20.0	4M-60	28-M7	21-MP													
2 33		-		-		_	_						-	_			Caco3				CaC03				CaC03											
AS (D) CA (D) CL1- CU (D) RE (D) RE (D) RE (D) RE (D) RO (D) NNI (D) NNI (D) NNI (D) NNI (D) NNI (D) SE (D)	102	SR>4XSA	107	66	96		SR>4XSA	87	SR>4XSA	117	93	86	96	93	110	96	<2.0	<0.003	<1.0	<1.0	<2.0	<0.001	<0.010	<5.0	<2.0	<2.0	<1.0	<0.00>	<1.0	<0.050	<0.050	<0.002	<0.003	<0.10	<2.0	<10.
	AS(D)	CA (D)	-1	C(D)	FE(D)	K(D)	MG(D)	MN(D)	NA(D)	NH3/N	NO2/NO3	PB(D)	SB(D)	SI-SIO2	SO4=	ZN(D)	ALK.	AS(D)	CA (D)	ਹੈ	03	(a) (b)	FE(D)	HARD	HC03	K(D)	MG(D)	MN (D)	NA(D)	NH3/N	NO2/NO3	PB(D)	SB(D)	SI-SI02	S04=	TDS

QC Prep Blank

WG030223-2

# AMERICAN ENVIRONMENTAL CONSULTANTS

ANALYTICAL DATA REPORT

GENESIS INC.

Batch No: WG030223

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LAB NO	COLATECTED DESCRIPTION	PARAMETER	PARAMETER VALUE	UNITS ANALYST	DATE UNITS ANALYST ANALYZED METHOD	
WG030223-3	. QC Lab Control Sample	, ALK.	66	*Recovery EH	09-MAY-03 310.1	
		AS(D)	102	*Recovery MK	28-MAY-03 6020	
		CA(D)	100	*Recovery MK	21-MAY-03 6010B	
		4	107	*Recovery JN	14-MAY-03 325.2	
		(a) (b)	104	*Recovery MK		
		· FE(D)	101	*Recovery . MK	21-MAY-03 6010B	
		HCO3	66	*Recovery EH	09-MAY-03 310.1	
		K(D)	107			
		(D) MG (D)	100	*Recovery MK		
		WIN (D)	98			
		NA(D)	102			
		NH3/N	101	*Recovery JN	12-MAY-03 350.1	
		NO2/NO3	94			
		(D) Bd	102	*Recovery MK	28-MAY-03 6020	
+		SB(D)	101	*Recovery MK	28-MAY-03 6020	
		SI-SIO2	92			
		SO4=	100	*Recovery JN	08-MAY-03 9036	
		TDS	105	*Recovery BD	09-MAY-03 160.1	
		ZN(D)	102	*Recovery MK	28-MAY-03 6020	
WG010202-4	Of Dural toute					
100000000	or publicate	ALK.	2.0	% RPD EH	09-MAY-03 310.1	
		- <del>-</del>	7		14-MAY-03 325.2	
		503	<1.	* RPD EH	09-MAY-03 310.1	
		HARD	7	* RPD MK	21-MAY-03 2340B	
		HCO3	2.0	% RPD EH	09-MAY-03 310.1	
		NH3/N	1.8	% RPD JN		
		NO2/NO3	<1	% RPD JN	16-MAY-03 353.2	
		S04=	2.5	* RPD JN	08-MAY-03 9036	
		TDS	1.3	% RPD BD	09-MAY-03 160.1	
ם בבכטבטטפו	And Water of Land and Land					
MS030223-3	We Mariix Spike Duplicate	AS (D)	<1	& RPD MK	28-MAY-03 6020	
		CA(D)	41	% RPD MK	21-MAY-03 6010B	
		CO (D)	<1	% RPD MK	28-MAY-03 6020	
		FE(D)	1.0	* RPD MK	21-MAY-03 6010B	
		K(D)	2.0	& RPD MK	21-MAY-03 6010B	
		(C) DW	1.9	* RPD MK	21-MAY-03 6010B	
		(C) NW	1.0	* RPD MK		
		NA(D)	<1	& RPD MK		
		PB(D)	3.0			

ANALYTICAL DATA REPORT

GENESIS INC.

(Project )
Batch No: WG030223

DATE UNITS AMALYST ANALYZED METHOD	28-MAY-03 6020	06-JUN-03 6010B	28-MAY-03 6020	310.1	6020	6010B	325.2	310.1	6020	6010B	2340B	310.1	6010B	6010B	6010B	60108	350.1	353,2	6020	6020	6010B	9036	160.1	6020
UNITS AMALYST	\$ RPD MK	\$ RPD MK		ppm CaCO3	mdd	mdd	mdd	ppm CaCO3	шdd	mdd	mdd	ppm CaCO3	mdd	wdd	шdd	mdd	mdd	mdd	mdd	mdd	mdd	mdd	mdd	mdd
VALUE	5.9	47	2.8	2.0	. 0.003	1.0	1.0	2.0	0.001	0.010	5.0	2.0	2.0	1.0	0.005	1.0	0.050	0.050	0.002	0.003	0.10	2.0	10.	0.010
Parameter	SB(D)	SI-S102	ZN(D)	ALK.	AS(D)	(A(D)	£-	003	(a) no	FE(D)	HARD	HCO3	K(D)	MG(D)	MN (D)	NA(D)	NH3/N	NO2/NO3	PB(D)	SB(D)	SI-S102	SO4=	TDS	ZN(D)
DATE/TIME COLLECTED DESCRIPTION	QC Matrix Spike Duplicate			QC Reporting Limit																				

3030223-5

NB NO

3030223-6

nless otherwise noted results are not blank corrected. NP = Collect time Not Provided.

May May May

### Laboraton Custody Seal Inta Use Only Lab. No. Phone no: (801) 263-5256 3422 South 700 West Your Customer Service Salt Lake City, Utah SEND REQUESTS TO: Yes TSC LABORATORY 84119 Representative is: preserved with preserved with Comments Jodie Haynes NO,/NO3 were Samples for metals were Samples for 2 ml. H,50, Shipping Airbill# [0:30] 5 ml. HNO, ASARCO Please Forward Results by: USMail A Red EX () Fax () Other Red Courier Company Name: 1185 CX Fed &x \*\* Filtered samples were preserved are Requested No Later Than Orchard Park, NY 14127 5.8-03 Services Requested Below 157 Highland Ave. \*\* See Table 2 Water Quality Orginal Report To: BRUCE CLARK MINE MANAGER Additional Copy Of Report To: JOE VOLOSIN Requested Analytical Parameters. Laboratory Services Request Form Analyses with 5 ml. HNO よるこ Received for Lab By: II. REPORT INSTRUCTIONS Environmental cocined By: Containers Time /2,30 No. of Time Please Specify Sample I.D./Description/Tag No. () Other Please analyze the enclosed samples for: Sale erson Requesting Service: BRUCE CLARK Please send the following supplies: ( ) Sampling media or containers TROY MINE . TYPE OF SERVICE REQUESTED: roject Description: TROY MINE WATER CHAIN OF CUSTODY RECORD ( ) Laboratory services forms Decant Pond MW-15-01 lant Requesting Service: PLANT INFORMATION amples Collected By: ortent: Ue Signutur et Bejow This Point our Project No .: /6/03 8:55am /6/03 9:00am ate & Time Sampling clinquished By: finquished By: spatched By:

REQUEST: Quality Assurance & Quality Control

### APPENDIX D

**SOIL INVESTIGATION RESULTS - FALL 2000** 

### **SOIL INVESTIGATION RESULTS - FALL 2000**

Soil	Soil	Soil	
Sampling Site	Sampling Site Description	Sample Number	Laboratory Number
NP-4	NE Impoundment Borrow Slope	SMCGI-1000-101	00-59060-1
NP-6	E Impoundment Topsoil Stockpile	SMCGI-1000-102	00-59060-2
NP-8	Native Forest Topsoil	SMCGI-1000-103	00-59060-3
NP-8	Native Forest Topsoil	SMCGI-1000-104	00-59060-4
NP-9	E Impoundment Borrow Slope	SMCGI-1000-105	00-59060-5
NP-10	Native Forest Topsoil	SMCGI-1000-106	00-59060-6
NP-10	Native Forest Topsoil	SMCGI-1000-107	00-59060-7
NP-11	Native Forest Topsoil	SMCGI-1000-108	00-59060-8
NP-11	Native Forest Topsoil	SMCGI-1000-109	00-59060-9
NP-12	Native Forest Topsoil	SMCGI-1000-110	00-59060-10
NP-12	Native Forest Topsoil	SMCGI-1000-111	00-59060-11
NP-13	Plant Site Borrow (USFS)	SMCGI-1000-112	00-59060-12
NP-13	Plant Site Borrow (USFS)	SMCGI-1000-113	00-59060-13
TSP-1	W Impoundment Topsoil Stockpile	SMCGI-1000-114	00-59060-14
TSP-2	W Impoundment Topsoil Stockpile	SMCGI-1000-115	00-59060-15
TSP-3	W Impoundment Topsoil Stockpile	SMCGI-1000-116	00-59060-16

### APPENDIX E

### WEED CONTROL PLAN

### **TROY MINE**

### WEED CONTROL PLAN

Genesis's Troy Mine site and the surrounding area is presently affected by spotted knapweed, meadow knapweed, orange hawkweed, meadow hawkweed, common St. John's-wort and oxeye daisy. Orange hawkweed and meadow hawkweed occur along the Stanley Creek Road and the pipeline. A population of meadow knapweed, an invasive weed the Lincoln County Weed Board (LCWB) is working hard to eradicate, is found along the Stanley Creek Road. A small population of black knapweed is present on the tailing embankment road. Genesis is proposing a weed management plan based on regional plans from the Kootenai National Forest (KNF) and Lincoln County Weed Board to combat these infestations.

The USDA-Forest Service Guide to Noxious Weed Prevention Practices sets forth the goals to prevent the spread of weeds in the pursuit of various activities. For mineral activities the guide lists two goals:

Goal 1. Incorporate weed prevention into project layout, design, alternative evaluation and decisions and include weed prevention measures, including project inspection and documentation in operation and reclamation plans.

Goal 2. To prevent conditions favoring weed establishment, minimize bare soil conditions and reestablish vegetation on bare ground caused by project disturbance. Retain bonds until reclamation requirements, including weed treatments, are completed, based on inspection and documentation.

Genesis will work with the Lincoln County Weed Board and the Kootenai National Forest to determine what types of controls will be used and the timing of control measures. To optimize the effectiveness of the weed control, Genesis will coordinate their weed control activities with those being carried out by the KNF and the LCWB. Feasibility of using biological controls will continue to be reviewed with both the KNF and the LCWB. Mechanical and cultural control efforts, by themselves, generally, have

not proven effective at containing or reducing widespread noxious weed infestations. However, some forms of mechanical and cultural control, such as tilling and mulching, may be appropriate at some of the flatter mine site reclamation areas. Roadside mowing, generally, does not prevent knapweed from flowering and going to seed so mowing may not be a viable option. Herbicide application has proven to be the most effective control method for the weeds found in the vicinity of the Troy Mine.

.

The types of herbicides to be used and the application rates will be determined in consultation with the KNF and the Weed Board. Annual roadside application of picloram or clopyralid, annual spot spraying of picloram for knapweed and other weeds on the tailing embankment and other hard to reach areas and multiple spot spraying control efforts throughout the growing season for Meadow Knapweed sites is proposed.

The State of Montana licenses herbicide applicators. Applicators are required to keep records showing amount of herbicide applied and date of application. The State also is responsible for checking that applicators are adhering to requirements for record keeping, training and storage. Genesis mine personnel responsible for noxious weed treatment will assure that any contractors are licensed.

Herbicides containing the following active ingredients have been approved for use in the KNF: Picloram, 2,4-D, Clopyralid, Dicamba, or Glyphosate. Only water-soluble amine formulations of these herbicides will be used in order to reduce the chance that herbicides could damage crops, native plants, or other non-target plants. Herbicides with these active ingredients are marketed under a variety of trade names. The EPA has approved all of these herbicides for controlling noxious weeds and lists any use restrictions on their labels.

Genesis would require that all applicators adhere to safe application methods and practices, thus reducing the health risk to applicators and on site visitors, and protect sensitive vegetation and waterways. Applicators are required to follow requirements for storage, mixing, use, and disposal of herbicides that are listed on the label of every

herbicide. The Environmental Protection Agency approves these requirements, and disregarding them is a violation of Federal and State laws.

Any high use areas where herbicides are used will be signed after spraying. Application rates would depend on the site, weed species, and control objectives and would not exceed label restrictions. Broadcast spraying will not be conducted where trees or shrubs have been planted. In these areas, weeds will be managed by mechanical or biological methods or by spot spraying in larger openings. All weed populations will be subject to a minimum of annual treatment.

Restoration seeding and appropriate fertilization will be conducted on disturbed sites as soon as seasonally appropriate when the disturbed sites are no longer needed for mine operation. Revegetation seed mixes and practices outlined in the approved Genesis Reclamation Plan will be followed. Though reseeding is done principally to prevent erosion, it helps inhibit invasion of disturbed sites by noxious weeds. Reseeding and revegetation has prevented weeds from spreading onto many disturbed sites.

Mine personnel responsible for the weed control program will be trained to recognize noxious weeds and will be responsible for conducting the noxious weed survey on the project area or seeing that it is completed. Training will include plant identification using both photographic specimen examples and will be coordinated with the LCWB to take advantage of their resources. The mine will maintain a list of declared noxious weeds in Montana along with descriptions and photographs at the mine site. Genesis will maintain a general map of the locations of known weed infestations within the permit area. For some weeds, such as spotted knapweed which is ubiquitous, mapping will not likely be a useful tool except on newly reclaimed areas such as the tailings impoundment surface.

The mine site area will be monitored to spot any new infestations. If any new weed species are discovered, both the KNF and the Lincoln County Weed Board will be notified. Genesis will maintain a file documenting location and extent of weed

infestations at the mine site. New infestations will be controlled at the first appropriate period following consultation with the KNF and the Weed Board.

Herbicide treatment areas will be documented and mapped annually. Genesis will record the locations of the weed treatments used for specific sites and information on any new sites. These records will be maintained at the mine site office and a summary report documenting new occurrences, treatment areas, plans for the next years activities and other pertinent information will be submitted to agencies annually. Effectiveness of the various weed control measures will be evaluated and revisions made when necessary.

### APPENDIX F

### WATER MONITORING PLAN

### WATER MONITORING PLAN

### **Introduction**

The purpose of the Operational Water Monitoring Plan for the Troy Mine is to:

- 1. Continue the collection of hydrologic data to provide a statistically valid database in areas of environmental concern;
- 2. Monitor water resources in the area for potential changes to historic baseline data; and
- 3. Address water-related issues, which may arise during the reclamation or restart of the Troy Mine.

### Groundwater

Groundwater monitoring will consist of periodic water level and water quality sampling of monitoring wells, springs and surface water expressions in the vicinity of the mine. Groundwater monitoring site locations are listed in Table F-1 and locations shown on Figure F-1. The five surface water sites listed in this table represent the furthest upgradient expressions of surface water in drainages around the mine and are intended to monitor changes in the quality of groundwater discharging to these drainages. During some sampling episodes Weasel Gulch has been dry and samples have been collected from Weasel Lake. Laboratory parameters to be measured during monitoring are shown on Table F-2.

TABLE F-1. TROY MINE GROUNDWATER MONITORING SCHEDULE

Monitoring Site	Monitoring Parameter	Monitoring Frequency
Mine water - outflow, adit pipe (SA-P)	Quality	Quarterly
Mine water - outflow, adit pipe (SA-P)	Flow	Continuous (daily average)
Mine water - service adit ditch (SA-D)	Quality	Quarterly
Mine water - service adit ditch (SA-D)	Flow	Continuous (daily average)
MW-1	Water level & quality	Annually
MW-2	Water level & quality	Annually
MW-3	Water level & quality	Annually
MW-4	Water level & quality	Annually
IW-1	Water level & quality	Annually
Toe ponds	Water level & quality	Quarterly
S-1 (Spring near toe ponds)	Water level & quality	Quarterly
MW-95-4	Water level & quality	Spring Summer Fall
MW-95-7	Water level & quality	Spring Summer Fall
MW-95-8	Water level & quality	Spring Summer Fall
MW97-12	Water level & quality	Spring Summer Fall
MW97-14	Water level & quality	Spring Summer Fall
MW-01-15	Water level & quality	Spring Summer Fall
MW-01-16	Water level & quality	Spring Summer Fall
Surface water – Ross Ck RCT 1	Quality and flow	Annually-during low flow
Surface water – Ross Ck RCT 2	Quality and flow	Annually-during low flow
Surface water – Emma Gulch	Quality and flow	Annually-during low flow
Surface water – Weasel Gulch	Quality and flow	Annually-during low flow
Surface water - Stanley Creek	Quality and flow	Annually-during low flow

Troy Water Monitoring Plan Revised February 8, 2004

### TABLE F-2. ANALYTICAL PARAMETER LIST FOR WATER SAMPLES

Common Ions

Sulfate Field Temperature (°C)
Chloride Flow or Static Water Level
Sodium (Na) Total Hardness (CaCO3)

Calcium (Ca) pH

Magnesium (Mg)

Total Suspended Solids (TSS)

Potassium (K)

Total Dissolved Solids (TDS)

Carbonate (CO3) Bicarbonate (HCO3)

Total Alkalinity (as CaCO3)

### **Nutrients**

Ammonia (NH3) (0.05 mg/L) Nitrite + Nitrate as N (0.01 mg/L) Total Phosphorus as P (0.001 mg/L)

### Trace Metals\*

Antimony (Sb) (0.003 mg/L)
Arsenic (As) (0.003 mg/L)
Copper (Cu) (0.001 mg/L)
Iron (Fe) (0.01 mg/L)
Lead (Pb) (0.003 mg/L)
Manganese (Mn) (0.005 mg/L)
Silver (Ag) (0.003 mg/L)
Zinc (Zn) (0.01 mg/L)

NOTE: DEQ Water Quality Bureau Circular 7 (WQB-7) (November 1998) Required Reporting Values (RRV) shown in parentheses.

\*In surface water samples, metals are analyzed for dissolved and total recoverable constituents. In groundwater samples, metals are analyzed for dissolved constituents.

Locations and characteristics of monitoring wells are provided in Table F-3.

TABLE F-3. TROY MINE WATER MONITORING SITES

SITE-ID	LOCATION (TRS)	WELL DEPTH (FT)	SCREEN INTERVAL	CASING MATERIAL
WELLS	LOCATION (TRS)	(F1)	INTERVAL	WATERIAL
MW-1	T30N,R33W,S31	290	55-100 & 160-280	6-inch dia.; steel
MW-2	T30N,R33W,S31	205	OPEN BOTTOM	6-inch dia.; steel
MW-3	T30N,R33W,S31	125	OPEN BOTTOM	6-inch dia.; steel
MW-4	T29N,R33W,S6	125	54-104	6-inch dia.; steel
MW95-4	T30N,R33W,S31	18	8 to 18	2-inch dia. PVC
MW95-7	T30N,R33W,S32	95	79 to 89	2-inch dia. PVC
MW95-8	T30N,R33W,S32	54.5	48 to 53	2-inch dia. PVC
MW97-12	T30N,R33W,S31	35	5 to 25	2-inch dia. PVC
MW97-14	T29N,R33W,S6	36	15 to 35	2-inch dia. PVC
MW01-15	T30N,R33W,S32	45	30 to 40	2-inch dia. PVC
MW01-16	T30N,R33W,S32	42	32 to 42	2-inch dia. PVC

In addition to the mine site groundwater monitoring, groundwater will be monitored at the concentrate loadout in Libby in accordance with Permit Revision 00093-04-001. There are two shallow wells and a drain that will be sampled in accordance with the schedules shown in Tables F-3 and F-4. Sample sites and sampling frequency are shown in Table F-3. Analytical parameters for the Libby loadout site are presented in Table F-5.

TABLE F- 4. TROY MINE LIBBY LOADOUT SITE GROUNDWATER MONITORING SCHEDULE

Monitoring Site	<b>Monitoring Parameter</b>	Monitoring Frequency
Loadout – MWLL-04-01	Water level & quality	Spring Summer Fall
Loadout – MWLL-04-02	Water level & quality	Spring Summer Fall
Inflow to drain at track door	Quality	Spring (if flow occurs)

## TABLE F-5. ANALYTICAL PARAMETER LIST FOR LIBBY LOADOUT SITE WATER SAMPLES

Trace Metals

Cadmium (Cd) (0.0001 mg/L)
Copper (Cu) (0.001 mg/L)
Iron (Fe) (0.01 mg/L)
Lead (Pb) (0.003 mg/L)
Nickel (Ni) (0.02 mg/L)
Manganese (Mn) (0.005 mg/L)
Silver (Ag) (0.003 mg/L)

Zinc (Zn) (0.01 mg/L)

NOTE: DEQ Water Quality Bureau Circular 7 (WQB-7) (November 1998) Required Reporting Values (RRV) shown in parentheses.

Groundwater samples metals are analyzed for dissolved constituents as specified by Section 4.1.1 (p. 75) - Methods for Chemical Analysis of Water and Wastes (EPA 600/40-79-020, revised March 1983).

### **Surface Water**

Parametrix has conducted surface water monitoring of Stanley, Fairway and Lake Creeks since 1986. In 1985, Envirosphere (now Parametrix) was retained as an independent contractor by MDHES and MDSL (now MDEQ) to develop a benthic macroinvertebrate monitoring program. This program (Cardwell and Knudsen, 1985) was modified slightly and jointly adopted by MDEQ and Asarco in 1987. The program included bioassay testing, macroinvertebrate monitoring, and water quality and flow monitoring three times per year.

The program was amended in 2000 (Parametrix, 2000) to include only annual monitoring during the summer. The rationale for this reduction was that: 1) statistical analysis of existing data demonstrates that collection of macroinvertebrate data three times per year does not increase the ability of monitoring to detect statistically significant changes or trends; and 2) MDEQ Rapid Bioassessment Macroinvertebrate Protocols (Bukantis, 1998) require only summer sampling (June 21 to September 21) for macroinvertebrates.

Since 2000, macroinvertebrate sampling has occurred on an annual basis in summer.

During operations, macroinvertebrate monitoring will continue on an annual basis during summer (Parametrix, 2003). Additionally, the six water-quality monitoring stations will

be sampled for flow and water quality three times per year, during the spring, summer, and fall (see Table F-6).

TABLE F-6. TROY MINE SURFACE WATER MONITORING SCHEDULE

<b>Monitoring Site</b>	<b>Monitoring Parameter</b>	<b>Monitoring Frequency</b>
LC-1	Quality and flow	Spring summer fall
LC-2	Quality and flow	Spring summer fall
LC-4	Quality and flow	Spring summer fall
FC-1	Quality	Spring summer fall
SC-2	Quality and flow	Spring summer fall
SC-15	Quality	Spring summer fall
SC-17A	Quality	Spring summer fall
LC-1	Macroinvertebrates	Late summer/early fall
LC-2	Macroinvertebrates	Late summer/early fall
LC-4	Macroinvertebrates	Late summer/early fall
FC-1	Macroinvertebrates	Late summer/early fall
SC-2	Macroinvertebrates	Late summer/early fall

### **Quality Control**

Field quality control (QC) samples will be collected and analyzed as part of the program for evaluation of data quality. Field duplicate samples will be collected to estimate field and laboratory precision. The required number of field duplicate samples will be 1 in 20 samples calculated on an annual basis. This requires three groundwater samples and two surface water duplicate samples per year based on the current sampling schedule.

Blank samples may also be collected to estimate the potential for sample cross contamination from sampling equipment depending on the method used for groundwater sampling. Equipment field blanks are not be required if dedicated sampling equipment is used. A sampling and analysis plan will be prepared describing specific sampling protocol and associated QC procedures.

### APPENDIX G

### REVEGETATION MONITORING PLAN

### REVEGETATION MONITORING PLAN

### REVEGETATION

Preliminary revegetation and test plots on the tailing impoundment at the Troy Mine have been monitored by Culwell et al. (1987), Sindelar (1996), Stephens (2000a, 2000b, 2003) and Culwell (2004). Monitoring to date has documented results of revegetation trials on the tailing impoundment surface and tree planting success on various mine disturbances. Undocumented revegetation monitoring by mine company personnel and consultants has been conducted periodically to ensure that seeded areas are providing erosion control.

Revegetation monitoring will continue during the pre-closure and closure phases of the operation. Monitoring will be designed to evaluate:

- Adequacy of revegetation to limit off-site sedimentation;
- Woody plant survival rates;
- Vegetation vigor to assess whether supplemental fertilization may be desirable;
- Diversity of seeded and invading species;
- Competition between herbaceous and woody species to determine if lower herbaceous seeding rates or other measures are desirable to promote woody species survival and growth;
- Noxious weed presence; and
- Prevalence of hydrophytic species in areas designated for wetlands establishment.

Newly seeded areas will be qualitatively evaluated at the end of the first growing season to assess erosion control and initial plant establishment. If off-site sedimentation is observed, appropriate Best Management Practices (BMPs) will be implemented. BMPs may include mulching of seeded areas, installation of silt fence or interception dikes, or such other measures as may be appropriate. Specific BMPs will be based on site conditions. If plant establishment is not adequate to limit erosion or provide successful revegetation, reseeding or interseeding will be conducted.

Quantitative revegetation monitoring will be conducted in years 2 and 5 following seeding and planting. Canopy cover by species and morphological class and ground cover (bare ground, rock, lichens, moss, litter and basal vegetation) will be estimated on randomly established 0.01-acre circular plots distributed throughout the reclaimed area. Sample size will be based on size of the reclaimed area and diversity of the reclamation. In general, sample size will not be less than 1 plot per 5 acres of revegetation, hence a 100-acre disturbance would have a minimum of 20 plots. Sampling intensity would be increased on smaller reclaimed areas to insure the area is adequately characterized.

Woody plant density and survival of planted trees and shrubs will be assessed on 0.1-acre circular plots centered on cover plots and by using staked rows established during planting.

If monitoring identifies areas with poor germination or growth, high woody plant mortality or other problems, these areas will be evaluated to ascertain causal factors. If necessary, reclamation techniques will be modified to address identified problems and the site

remediated by reseeding, interseeding, supplemental planting or fertilization, or other mitigation appropriate to the problem and site. Revegetation techniques and seed mixes/planting rates may be modified, with agency approval, to reflect evaluations of revegetation monitoring.

### **APPENDIX H**

### GEOTECHNICAL MONITORING PLAN

# GEOTECHNICAL MONITORING PLAN TROY MINE TAILINGS IMPOUNDMENT

Prepared for:

**Revett Silver Corporation**Troy, Montana

Prepared by:

**Hydrometrics, Inc.** 3020 Bozeman Avenue Helena, MT 59601

May 2004

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# GEOTECHNICAL MONITORING PLAN TROY MINE TAILINGS IMPOUNDMENT

### 1.0 INTRODUCTION

In response to a request from the Montana Department of Environmental Quality (DEQ, 2001), this document provides a plan for monitoring the safe performance of the Troy Mine Tailings Impoundment, as outlined in 30CFR, Ch. VII, 817.49. Monitoring shall include:

- 1. Visual inspection of the impoundment, its appurtenances, the downstream area, and all other areas affected by the structure *(Section 2)*;
- 2. Collection and evaluation of data from instrumentation (Section 3);
- 3. Evaluation of maintenance requirements (Section 4); and
- 4. Analysis of existing storage capacity (Section 5).

### 2.0 VISUAL INSPECTION

30CFR817.49 requires that the impoundment be inspected at least yearly and that this inspection be under the direction of a qualified engineer. To allow consistent inspection of the impoundment, the engineer will use the inspection checklist and guidance from *Dam Safety: An Owner's Guidance Manual* (FEMA). A copy of this checklist is contained in Appendix A.

In addition to the annual inspection by a qualified engineer, inspections should be performed after major precipitation events or after observed changes in seepage, stability, or water level of the impoundment. Site personnel who are knowledgeable of the impoundment may perform these unscheduled inspections. The checklist in Appendix A should also be used to document these inspections.

#### 3.0 INSTRUMENTATION AND MONITORING

Instrumentation of the impoundment furnishes data to determine if the structure is functioning as intended and to provide a continuing surveillance of the structure to warn of any developments that threaten its safety. During operation of the impoundment, two areas of monitoring are key to its performance. These include monitoring of seepage from the impoundment and monitoring of the piezometer levels in the embankment. If the embankment is raised, monitoring of any embankment movement will also be necessary.

#### 3.1 SEEPAGE MONITORING

Seepage from the impoundment may be related to the water surfacing at Seep S-1 and should be monitored to verify that the flow from this seep is stable and not progressively increasing. The seepage should be collected in the existing drain trench and the amount of flow monitored monthly. If possible, this flow data should be collected for the same days that measurements from the nearest piezometers, 2-1 and 2-2, are recorded. At the time of the next inspection, the engineer in charge should determine if a correlation exists between piezometer levels measured in the vicinity of Seep S-1 and the flow measured from the seep. If a correlation exists, it can be used to determine if seepage flow is increasing over time. If it doesn't, peak seepage flows should be measured and compared yearly in order to determine if seepage flow may be increasing.

#### 3.2 PIEZOMETER LEVELS

Water levels in at least fifteen piezometers located around the periphery of the impoundment should be measured monthly and monitored to ensure that the water table through the embankment does not exceed safe levels. Table 3-1 lists the maximum allowable water levels for each piezometer as determined from the original design assumptions for the embankment.

TABLE 3-1. MAXIMUM ALLOWABLE PIEZOMETER LEVELS

PIEZOMETER	MAXIMUM WATER LEVEL
1-2 a	2344
1-2 b	2352
2-1 a	2344
2-1 b	2339
2-2 a	2345
2-2 b	2348
3-1 a	2339
3-1 b	2343
3-2 a	2341
3-2 b	2342
4-1 a	2344
4-1 b	2343
4-2	2340

### 3.3 EMBANKMENT STABILITY

Prior to construction of an embankment raise, survey control points should be established on the existing embankment in order to monitor it for possible movement.

#### 4.0 MAINTENANCE

A good maintenance program will protect the tailings impoundment against deterioration and prolong its live. During each annual inspection, a checklist of items calling for maintenance should be developed. The inspection checklists have a column specifically for that purpose. There are three categories of maintenance required for the impoundment: immediate, assoon-as-possible, and continuing maintenance.

### 4.1 IMMEDIATE MAINTENANCE

The following conditions are critical and call for immediate attention:

- Overtopping of the embankment;
- Breaching of the embankment;
- Piping or internal erosion of the embankment indicated by increasingly cloudy seepage or other visual signs; and
- Evidence of excessive seepage below the embankment.

### 4.2 MAINTENANCE REQUIRED AS SOON AS POSSIBLE

The following maintenance items should be completed as soon as possible after the defective condition is noted:

- Removal of tree or brush that obscure the view of the embankment;
- Restoration of erosion gullies; and
- Repair or replacement of defective pumps, valves, or piping necessary for controlling the impoundment water level.

#### 4.3 CONTINUING MAINTENANCE

Several tasks of general maintenance, such as mowing, should be performed on a continuing basis.

### **5.0 STORAGE CAPACITY**

The impoundment area of should be measured annually and the storage capacity determined in order to verify that it has sufficient storage capacity to impound the runoff from a 100-year, 24-hour precipitation event. This required storage capacity is estimated to be approximately 200 acre-feet of water.

## APPENDIX A

**INSPECTION CHECKLIST** 

OBSERVATIONS		EMBANKMENT	CH	CHECK (ACTION NEEDED
	CONDITION	OBSERVATIONS	AOTINOM	GVIE INAEZII-
	SURFACE CRACKING			
ALIGNMENT PUDDLES CONDITION H, SCARP CTION ONTACT CONDITION	CAYE IN, ANIMAL BURROW			78000
	LOW AREA(S)			
	HORIZONTAL ALIGNMENT			
	RUTS AND/OR PUDDLES			
	VEGETATION CONDITION			
	SLIDE, SLOUGH, SCARP			
	SLOPE PROTECTION			
NO	SINKHOLE, ANIMAL BURROW			
	EMBABUT. CONTACT			
		s ( ) d de se de s	-	

		EMBANKMEN! 2 of 2	ACTION	TON
LLEW NO	CONDITION	OBSERVATION	MOTINOM	GATE INVESTI-
17 WE	WET AREA(S) (NO FLOW)			
18 SE	SEEPAGE			1
19 SL	SLIDE, SLOUGH, SCARP			1
20 EN	EMBABUT. CONTACT			
21 CA	CAVE IN, ANIMAL BURROW			
22 ER	EROSION			1
23 UP	UNUSUAL MOVEMENT			
24 VE	VEGETATION CONTROL			
22				7
76				
27 PI	PIEZOMETERS/OBSERV. WELLS			
28 ST	STAFF GAUGE AND RECORDER			
29 W	WEIRS			7
30 ST	SURVEY MONUMENTS			
31 DF	DRAINS			1
32 FR	FREQUENCY OF READINGS			
33 1.0	LOCATION OF RECORDS			7
34				
35				

## APPENDIX I

## TAILING FACILITY STABILITY REPORT

## 2000 INSPECTION MEMO

CONDITIONS OF TAILINGS POND
GENESIS INC., TROY UNIT
LINCOLN COUNTY, MONTANA

for

GENESIS, INC.
TROY, MONTANA

GEORGE C. TOLAND Consulting Georgeonnical Engineers 2558 South 550 East Bountiful Utah 84010

### **GEORGE C. TOLAND**

Consulting Geotechnical Engineers
2558 South 550 East Street • Bountilul, Utah 84010 • (801) 295-1078

October 17, 2000

GENESIS INC. A Subsidiary of Sterling Mining Troy Project P.O. Box 1660 Troy, Montana 59935

Attention: Mr. Bruce Clark

Dear Bruce

2000 INSPECTION MEMO CONDITIONS OF TAILINGS POND GENESIS INC. TROY UNIT LINCOLN COUNTY, MONTANA

## 1.0 INTRODUCTION

This letter presents the results of our October 11, 2000, inspection of the ASARCO tailings disposal system near Troy, Montana. The ownership of the property changed from ASARCO, Inc. to GENESIS INC.during the present year. Mr. Bruce Clark, Mr. Dave Young, and Mr. Rod Johnson (now GENESIS INC. employees) discussed the past year's maintenance and re-vegetation activities on the tailings Pond. Mr. Johnson accompanied Mr. Toland on the inspection. Fourteen photographs of the tailings pond are presented on the attached Plates 1A through 1G.

Mining and tailings disposal ceased in April of 1993 and were not expected to resume in the near future. However, with the new ownership, resumption of the mining and milling operation may be as early as late summer of 2001. Discussions and descriptions presented in this letter reflect conditions that exist in this, the seventh year of stand-by operation of the Tailings Disposal System.

Annual inspection reports, similar to this report, have been provided to ASARCO Inc. for the past 19 years. A more complete presentation of the conditions of the

tailings pond, the data monitoring, and conclusions made in 1993, were presented in our 1993 Inspection report, dated September 29, 1993. The tailings pond data presented in 1993 have not changed and are considered a part of this 2000 Inspection Memo.

## PROJECT DESCRIPTION

Until the present stand-by period, ASARCO Inc., operated the Troy, Montana, underground copper/silver mine. The mine is located in the northwest corner of Montana, approximately 20 miles southwest of Libby, Montana. The Troy Mine operated for approximately 12 years and still has an estimated 4 years of ore reserves remaining. With the rate of tailings disposal that has occurred for the past several years of operation, the future tonnage to be deposited in the pond will be approximately 12 million tons.

Plans, specifications, and design recommendations for the tailings pond system were provided by Dames and Moore. Pond operation, monitoring, and daily inspections were ongoing functions of ASARCO personnel. These functions are now being conducted by GENESIS INC.

## DISPOSAL SYSTEM DESIGN

The Troy, Montana, tailings disposal system has utilized an upstream construction tailings pond. The pond was constructed on a sidehill location and has three constructed sides with a natural hillside forming the fourth side. Storm water ditches divert water around the tailings area and deposit the runoff into designated collection ponds (toe ponds). The original starter dam was constructed of in-situ soils from within the pond area. Subsequent embankment raises have utilized the compacted tailings material for construction. Topsoil has been used for embankment cover and selected portions of the raises. The discharge system is a perimeter type system that discharged tailings from closely spaced spigots along the constructed three sides of the pond. Piezometers were installed to monitor phreatic water in the embankment as the pond elevation increased.

Mine water continues to be collected in the decant pond area and is used for surface irrigation. Grass is maintained on all embankment slopes and until the mine shut-down period barley was planted yearly on the pond surface to reduce wind erosion. For the past six years cattle have been grazed on the grass growing on the pond surface. In the past, hay mulch was used to enhance the growth of grass on the pond surface. In 1997 a planting area research study was conducted in the center of the tailings area, using varying thicknesses of natural

soils covering the tailings. Starting in 1998 an extensive re-vegetation effort was undertaken using grass and transported large native trees. This effort continued and enlarged in 1999. Bank-run material from east of the tailings area has been spread near the pond crest to reduce blowing of tailings and to enhance the re-vegetation program. In 2000 the re-vegetation program is still in operation. Irrigation is continuing, but re-vegetation has been less than in 1998 and 1999.

The pond design recommendations previously provided by Dames and Moore were presented in our 1993 Report. The monitoring data maintained by ASARCO for pond control purposes will continue to be collected by GENESIS INC., during the mine shut-down period. A more detailed plan for monitoring and slope stability evaluation will likely be needed when mining operations resume.

## 4.0 POND OBSERVATIONS

Until the recent mine shut-down, the tailings pond was operated in three individual quadrants. Each quadrant was filled and allowed to dry prior to constructing the embankment raise for that quadrant. Embankment raises were constructed with scrapers that operated on the tailings beach, hauled the tailings to the embankment area, placed the tailings in layers, and compacted each layer by utilizing construction traffic. During full time operation of the mill, each embankment raise was 10 feet in height and an embankment raise was required for one quadrant per year. The use of either cyclones or drag lines to construct embankment raises was discussed with ASARCO during previous inspection trips. Both options would be feasible for the Troy tailings pond. However, the scrapers are able to operate on the dry tailings beaches, and can construct a compacted embankment raise at a relatively low cost. GENESIS INC. will likely continue with this method of constructing embankment raises for future operations.

Until the shut-down period, the spigoted tailings discharge system operated well. The spigots were controlled so that each new embankment raise was filled uniformly along the embankment face. Pressure head to operate the spigots was provided by elevation head from the mill. Loss of head that was experienced some years back was the result of scale buildup in the discharge lines. This problem was resolved by periodically cleaning of the lines. However, at some future date it may be necessary to install a booster pump to maintain discharge pressure.

During the period of operation, the barge decant pump operated in an excavated decant pond at the far upstream end of the pond. Pipes were used to direct the

decant water from each of the three quadrants into this pond for return to the mill or to be used as irrigation water and maintain erosion protection vegetation. The barge has now been removed from the decant pond and irrigation pressure is maintained by the pressure head from the mine.

Topsoil was placed on the downstream side of each new embankment raise as it was constructed. Grass was then seeded and irrigated with sprinkler systems. The central portion of the unused quadrants was planted with barley each year to reduce the wind erosion effects on the center of the ponds. The barley has now been replaced with grass on all quadrants of the pond and, as stated previously, large trees have been transplanted in certain areas. Cattle have been grazing on the pond during the present growing season.

The phreatic water level in the pond embankment has been monitored with wellpoint-type piezometers during the life of the pond. Phreatic water level readings on these piezometers have been obtained twice monthly by ASARCO engineering personnel. A copy of the plotted data maintained by ASARCO obtained for August, 1998, through September 2000, are presented as Plates 2A through 2D, Piezometric Data. Previous data for years 1995 through 1998 are presented in our 1998 memo. As can be noted from the plots, there is no indication of buildup in the phreatic surface that would influence the overall stability of the embankment, or directly cause the surface sloughing discussed in our 1989 report.

### 5.0 TOE POND EVALUATIONS

The toe ponds were constructed on the downstream toe of the tailings pond to collect and pump back runoff water from the tailings pond embankment slopes. The toe ponds cover essentially the entire west side of the tailings pond. The toe ponds are narrow and quite shallow. The maximum depth is estimated to be less than 10 feet. Several of the toe ponds were essentially dry at the time of this inspection.

The tailings pond and the toe ponds were constructed in 1981, and there have been essentially no embankment stability concerns during this 19 year time span. Some 90 percent of the dams and pond embankments that fail occur upon initial filling. The long period of successful operation of this tailings system indicates that embankment failure is very remote. Phreatic water level monitoring and past stability analyses confirm this assumption.

## 6.0 PIPING CONCERNS

In 1991, an inspector from the Montana Department of State Lands, Hard Rock Mining Division, raised a question of the possibility of a piping (internal erosion) failure of the toe ponds. This was based on a sink hole and an erosion tunnel that formed west of the toe ponds. This tunnel was observed during our 1990 inspection and was not considered significant. The area of collapse is several hundred feet from the toe ponds and has little elevation change that would cause a steep pressure gradient. There is an abrupt change in grade below the tailings pond where the bench area which supports the tailings pond breaks down to the channel of Lake Creek. This break in grade occurs immediately below the tunnel and the tunnel appears to follow an old erosion channel that was filled with loose topsoil.

The water that created the tunnel came from runoff from snow melt on the topsoil stockpile area west of the tailings dam. There is no indication that toe ponds water has had any influence on the tunnel formation and no water was flowing in the tunnel at the time of our 1991 inspection. The soil above the tunnel was dozed out and the sink hole and the tunnel area was filled with gravel in 1991 after our 1991 inspection.

Analyses of the toe ponds and the steep area west of the toe pond embankments should be part of the preparations for resuming mining and milling operations.

### 7.0 TREES ON EMBANKMENT SLOPE AND TAILINGS SURFACE

During our 1994 inspection, it was observed that numerous small pine trees and a clump of alders were growing on the tailings pond embankment slope. These trees look healthy and improve the appearance of the embankment. There have been questions raised as to stability problems that these trees might cause. The tailings pond does not have water adjacent to the crest, and loosening of the soils on the embankment slope by root growth would be insignificant. Therefore, there is no reason to believe that the root system from these or any future trees would cause stability or piping problems.

Trees of various types were planted on the west side of the embankments near the southwest corner during 1995. Planting of trees has continued during 1996 and 1997. The planting area has been expanded until at the present time most of the embankment area and part of the tailings surface area are covered. The trees appear to be doing quite well.

The trees are predominantly native species of evergreens. Some of the transplanted trees are over 15 feet in height. Both the trees and the grass around the trees appear to be doing well.

## 8.0 SLOUGHING OF STEEP NATURAL SLOPES

West of the toe ponds the ground surface makes a steep break and slopes steeply (approximately one horizontal to one vertical) to Lake Creek. The wetter than normal weather during 1996 and 1997 caused some minor sloughing at several locations along the break area. Our conclusions in our 1997 letter was that the sloughing is not significant and shows no sign of progressing to the toe pond area. Stabilizing with granular fill was done in 1991 but was not required for the 1997 sloughing. Sloughing is extremely minor in 2000.

## 9.0 ENVIRONMENTAL CONCERNS

During our field inspection in 1997, Mr. Luchini indicated that an environmental group was filing a law-suit against ASARCO claiming pollution of Lake Creek. One of the items listed was iron contamination from the tailings pond. Mr. Luchini and I looked at the iron stains on the gravel near the pump-back sump below the south toe pond. We also walked to Lake creek and looked for more stains. The stains near the creek are very minor and the flow of water minimal. There was no indication that the iron stains came from the mining operation or that the seepage had any adverse effect on Lake Creek. Photograph 13, taken during the current inspection, shows no indication of any increase in the stated problem.

## 10.0 CONCLUSIONS

As stated previously, the mine and mill were placed on stand-by in April of 1993. However, ASARCO and now GENESIS continue to maintain a high level of control over environmental degradation on their mining property. Photographs taken during our October 11,2000, inspection are presented on Plates 1A through 1G. The ability to operate scrapers on the tailings beach indicates that the strength of the beach material is considerably higher than strength properties assumed in design. Therefore, the overall embankment stability is equal to or greater than the values quoted by Dames and Moore. The sloughed area described in the 1993 report is a surface-type slide and does not influence the overall stability of the

embankment. The alder and pine trees growing on the embankment slope do not influence the stability of the slope. Planting of additional trees and grass, as is in progress, should improve the appearance of the pond area and will not cause any stability concerns

The discharge system is now being used to discharge mine water for irrigation only. The decant pond will remain in it's present location and be used for irrigation purposes.

The phreatic water surface, measured by the piezometers along the west embankment, has not changed significantly in the past several years. This pattern is expected to continue during the stand-by period. The discharge of clear water only into the tailings pond should not create a problem with the phreatic water levels. If either increased seepage or muddy seepage should be observed at the toe or on the face of the tailings pond embankment, please call us for further evaluation.

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Respectfully submitted,

George C. Toland Professional Engineer

2911E. State of Montana

GCT/hbt

Attachments:

Plates 1A through 1G Photographs

Plates 2A through 2D Piezometric Data



PHOTO 1: SOUTH SIDE OF TAILINGS POND LOOKING EAST. UPSTREAM SLOPE, CREST, AND OPERATING SPRINKLER SYSTEM ARE SHOWN.



PHOTO 2: SOUTHWEST CORNER OF TAILINGS POND LOOKING NORTHWEST. THE CREST, UPSTREAM SLOPE OF THE EMBANKMENT AND OPERATING SPRINKLER SYSTEM ARE SHOWN.

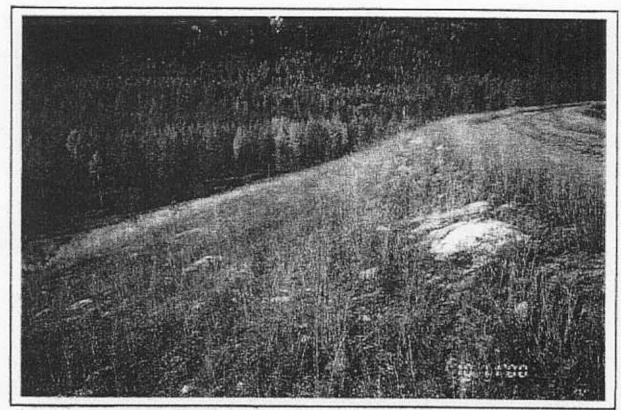


PHOTO 3: SOUTHWEST CORNER OF TAILINGS EMBANKMENT LOOKING WEST. THE CREST AND THE DOWNSTREAM SLOPE OF THE EMBANKMENT ARE SHOWN.



PHOTO 4: DIVIDING DIKE BETWEEN TAILINGS POND CELLS 1 AND 2. A PLANTING AREA ON CELL 2 AND THE DIVIDING EMBANKMENT ARE SHOWN.

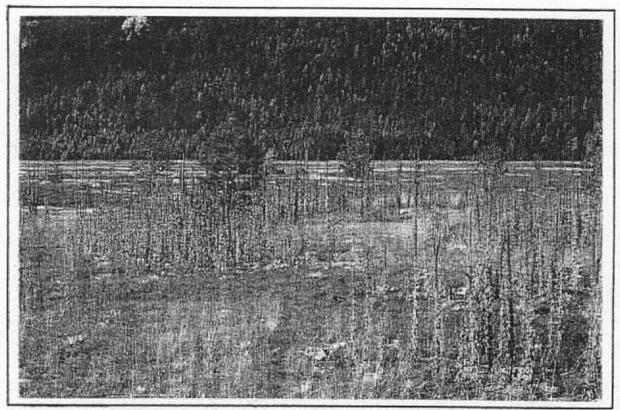


PHOTO 5: PHOTO TAKEN FROM EASTERN SIDE OF DIKE DIVIDING CELLS 1 & 2, SHOWS LARGE WEEDS AND TREES FROM CURRENT PLANTING OPERATION.



PHOTO 6: DIVIDING DIKE BETWEEN TAILINGS POND CELLS 2 & 3. SHOWS TREES PLANTED IN CELL 2 AND MINE WATER PONDED IN CELL 3.

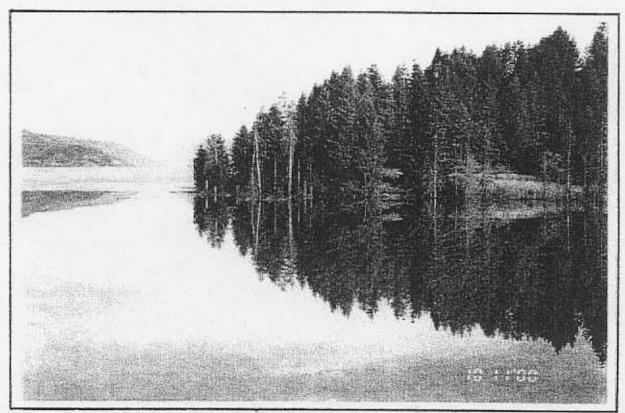


PHOTO 7: FROM ROADWAY NEAR DECANT WATER POND LOOKING NORTH. THE PONDED MINE WATER AND THE TAILINGS BEACH AREA IN TAILINGS POND CELL 3 ARE SHOWN.



PHOTO 8: EAST END OF TAILINGS POND LOOKING SOUTH. THE UNUSED DECANT WATER RETURN POND AND SPRINKLERS OPERATING IN CELL 2 ARE SHOWN.



PHOTO 9: LOWER ACCESS ROAD LOOKING NORTHEAST. THE ACCESS ROAD AND TREES PLANTED SEVERAL YEARS AGO ON THE DOWNSTREAM SLOPE OF THE TAILINGS POND EMBANKMENT ARE SHOWN.



PHOTO 10: LOWER ACCESS ROAD LOOKING SOUTH. A PIEROMETER ON THE DOWNSTREAM SLOPE OF THE TAILINGS POND EMBANKMENT, A TOE POND AND A TOPSOIL DISPOSAL AREA ARE SHOWN.

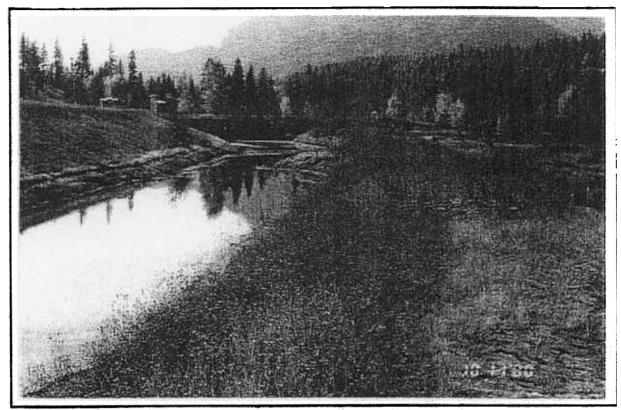


PHOTO 11: FROM WEST EMBANKMENT OF THE TOE POND DIKE LOOKING SOUTH. THE LOWER ACCESS ROAD, THE TOE OF THE ORIGINAL STARTER DAM, THE TOE POND, AND THE WEST EMBANKMENT OF THE TOE POND ARE SHOWN.



PHOTO 12: FROM THE WEST EMBANKMENT OF THE TOE POND DIKE LOOKING WEST. THE TOPSOIL DISPOSAL AREA AND THE LOCATION WHERE THE NATURAL SLOPE STEEPENS EAST OF LAKE CREEK ARE SHOWN.

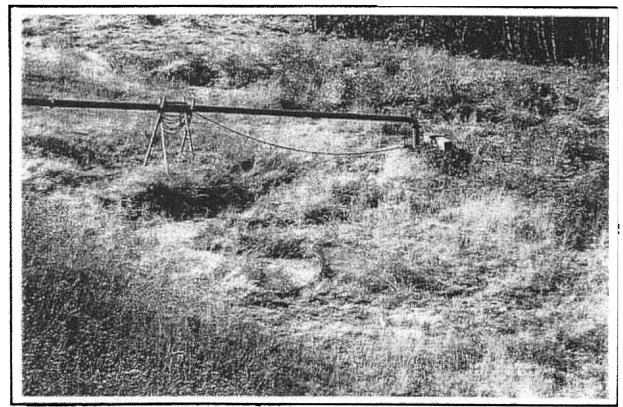
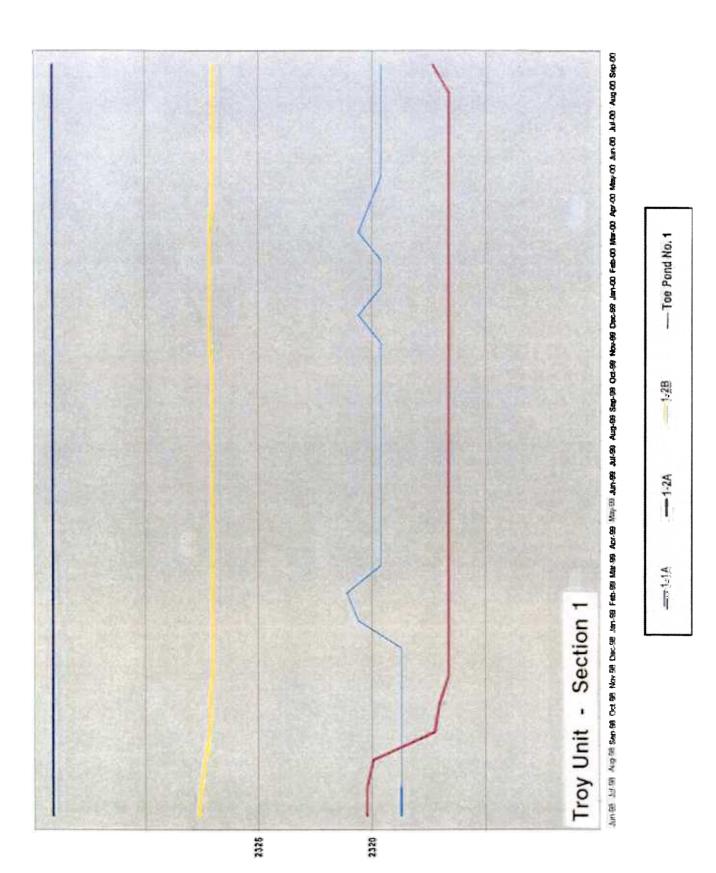


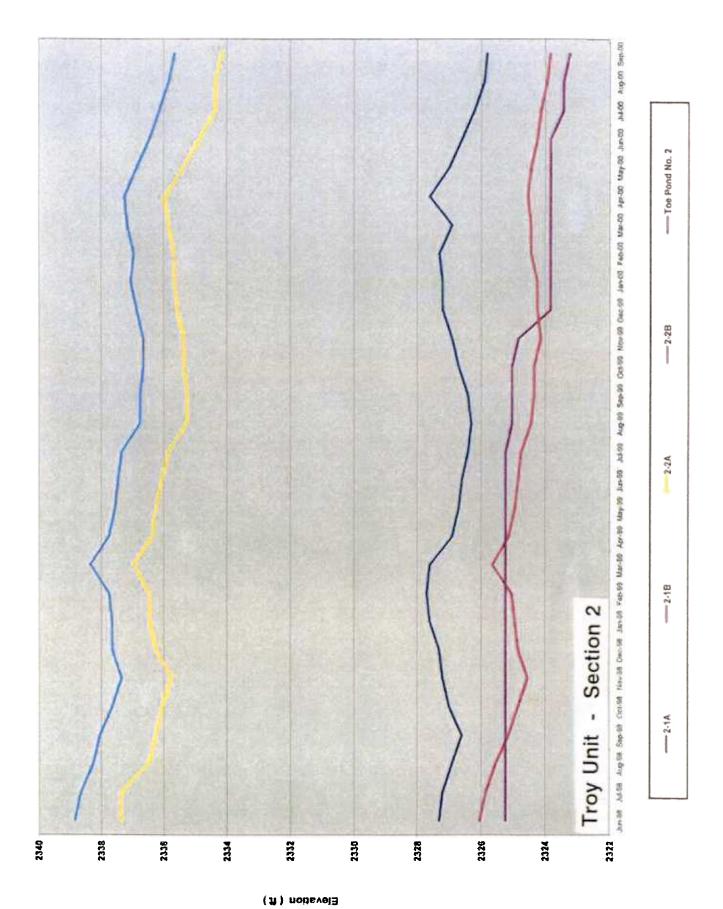
PHOTO 13: SUMP AND PUMP DOWNGRADE OF THE TOE PONDS WHICH WERE INSTALLED IN 1991 TO COLLECT SEEPAGE ARE SHOWN.

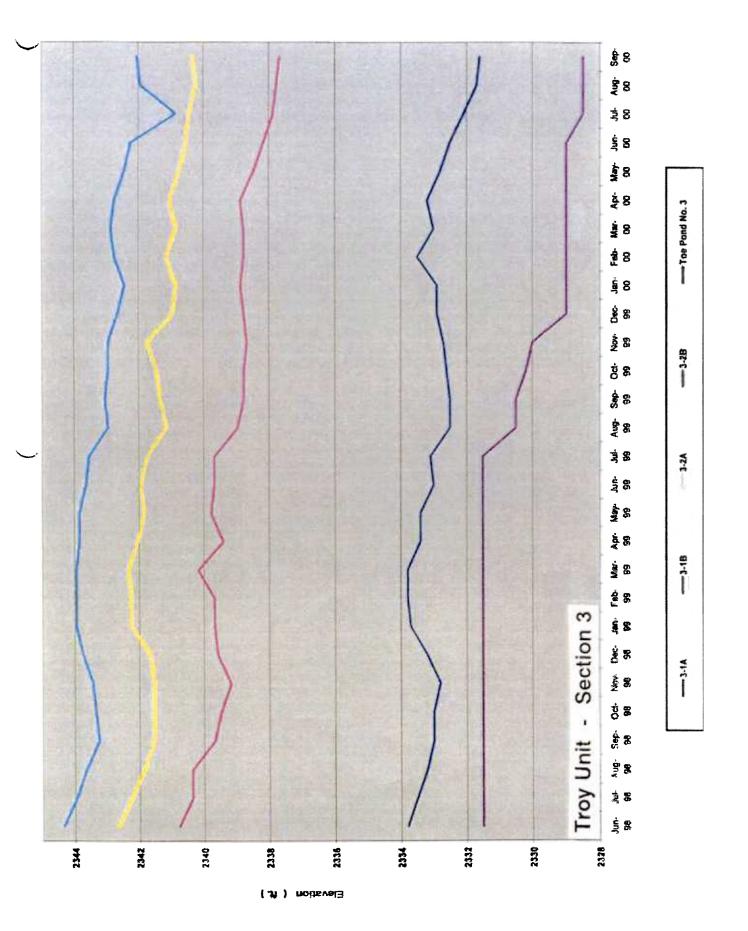


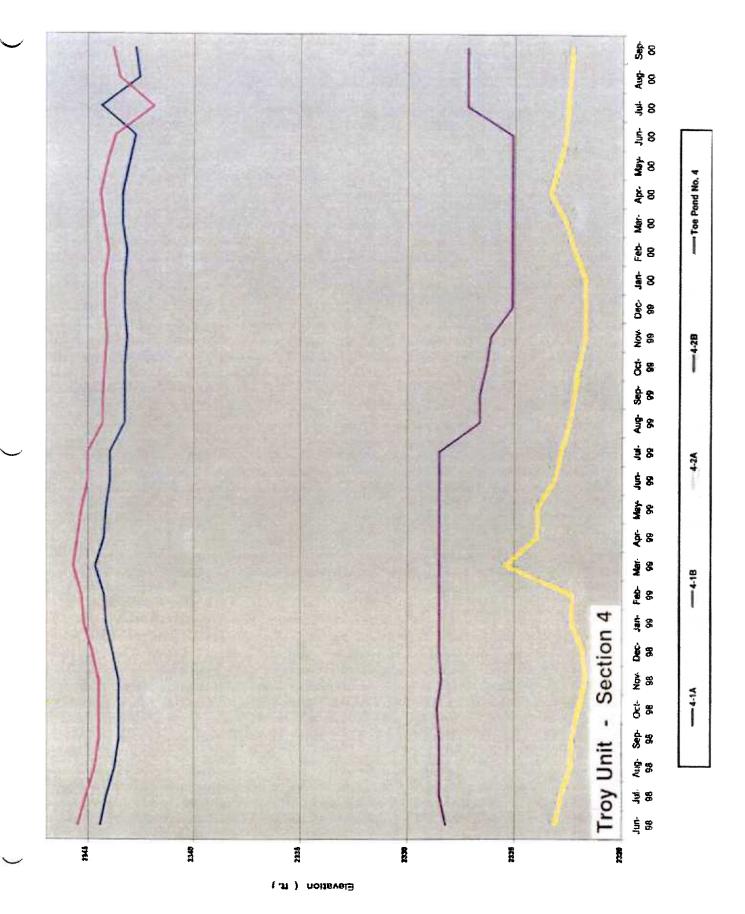
PHOTO 14: FROM A POINT ON THE DOWNSTREAM SLOPE OF THE TAILINGS EMBANKMENT LOOKING NORTH. THE TOPSOIL IN THIS AREA WAS NOT THICK ENOUGH TO COVER THE TAILINGS AND SUPPORT VEGETATION.



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## APPENDIX J

CONCEPTUAL TUNNEL PLUG STUDY

# **Sterling Mining Company**

## **TROY MINE**

## Conceptual Tunnel Plug Study

SUBMITTED BY KLOHN CRIPPEN (a member of the Louis Berger Group)

PM 8925 01







October 30, 2000

Sterling Mining Company 424 South Sullivan Road, Suite 300 Veradale, Washington 99037

Mr. Frank Duval

Dear Mr. Duval:

### Troy Mine - Conceptual Tunnel Plug Study

This report presents Klohn Crippen's preliminary assessment of the use of tunnel plugs to control groundwater discharge from the Troy Mine.

The local rock is well suited for tunnel plug construction and we feel that tunnel plug construction could provide significant benefits, in terms of reducing surface water handling. Plug construction and placement will require co-ordinated knowledge of the civil/geotechnical design issues with understanding of the hydrogeology of the area.

Thank you for this opportunity to work with you on the Troy Mine. We look forward to the success of your efforts to re-open.

Yours truly,

KLOHN CRIPPEN CONSULTANTS LTD.

Len Murray, P.E. Project Manager

cc. Dave Young



# **Sterling Mining Company**

## **TROY MINE**

## Conceptual Tunnel Plug Study

SUBMITTED BY KLOHN CRIPPEN (a member of the Louis Berger Group)

PM 8925 01 OCTOBER 2000

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### 1. INTRODUCTION

At the request of Mr. Frank Duval, Sterling Mining Company (SMC), Mr. Len Murray, P.E. of Klohn Crippen Consultants (a member of the Louis Berger Group) visited the Troy Mine on October 11 and 12, 2000. The scope of work included a preliminary inspection of the underground mine to assess if sites could be located for construction of tunnel plug(s) to control ground water discharge from the workings. Groundwater is currently directed by pumping or seepages to underground water reservoirs where it is collected and piped to the tailing area some 6.5 miles away. At the tailing area the water is used for dust management and reclamation irrigation purposes or is clarified and discharged to groundwater. The tailing area water quality issues are being addressed by others.

Control of the water by tunnel plugs, grouting or other means could reduce operating costs by reducing pumping. More critically, control, reduction or elimination of groundwater reporting as surface water from the workings will have important implications for mine closure, long term water treatment, and bonding requirements.

On October 12, a meeting was held between SMC, their consultants and the state regulators to discuss issues related to mine re-opening. Meeting attendees are listed in Appendix I along with some notes on technical issues raised.

## 2. PRELIMINARY OBSERVATIONS RELATED TO UNDERGROUND MINE

Len Murray spent about 2 hours underground looking at issues related to groundwater flows and possible tunnel plug or grouting sites. A plan drawing of the workings and a surface plan of disturbed areas are included in Appendix II. The inspection did not consider stability of the underground workings and was not extensive enough to draw any conclusions about stability of the workings. The following sections provide a preliminary assessment of the underground conditions as related to tunnel plugs, grouting or other groundwater control issues.

## 2.1 Geological Conditions

Entrance to the underground workings is through the 1 mile long service adit, which runs at an upgrade of about 10% and is entered from behind the above ground Secondary Crusher area. The mine has been excavated by a room and pillar method into very competent Quartzite. The mine contains an under ground primary crusher area which feeds crushed ore via an ore bin to a conveyor adit which runs parallel and about 30ft from the service adit. SMC are regenerating sections to show the geometry of the workings, but these drawings are not yet available.

The host Quartzite rock is strong probably R4 or R5 on the ISRM (1977) scale and likely has an unconfined compressive strength, in undisturbed conditions, in excess of 7,000psi, (reported by SMC to exceed 25,000 psi). The Quartzite is relatively thickly bedded with continuous bedding planes spaced at about 3 ft to 6 ft vertical intervals; the bedding appeared to dip gently to the South. Generally the bedding planes were tight except where thin (normally less than 1 inch thick) ore bearing intrusions occurred.

At least two subvertical joint sets were observed and likely ran sub parallel to series of major NW trending and SW trending faults which cut the ore body. The major faults are

shown in plan on a drawing dated August 2000 provided on site by Mr. David Young of SMC. The drawing is attached to this report and is a part of the preliminary data reclaim process being initiated for the mine.

The subvertical joints were generally continuous but varied in orientation, the joints also varied in infill characteristics from tight to open or infilled with ore bearing intrusions. There appeared to be a continuum of joint conditions from tight through to the condition of the major faults as discussed below. The vertical joints and faults appear to be the major conduit for groundwater inflows to the Mine.

The major faults shown on the plan were inspected in several locations and are major structural features. Although no offsets were measured, it is reported by Sterling that the faults cause significant vertical offsets in the ore body. The cross fault between the North and South ore body and the East fault split the ore body into three zones, denoted the North Ore Body, South Ore Body and East Ore Body respectively. There are many other faults running through the ore body with less thickness or off set than the major structures shown on the drawing. The faults likely run in sympathetic directions to the main faults and as indicated the faults seem to grade through to joints.

In fill in the faults consists of white clay gouge which is reported to contain Talc. The clay gouge may be heavily altered pegmatite or other material intruded with the ore and altered by gases, fault movement and/or water flow. The infill is up to several feet wide and is very weak; it can easily be scraped out by hand. There are many areas of ground support, including steel sets with wood lagging, to support the rock in the fault zones. This contrasts to the openings in intact quartzite, which were mostly unsupported, apart from roof support, where bedding plane slabs require bolting in the flat crown of the openings.

### 2.2 Groundwater Inflows

Based on observations and discussions with Dave Young, the mine water is currently controlled in the three mine zones as follows:

- The northern portion of the North Ore Body is the highest part of the ore body and does not retain water or have significant inflows;
- The southern portion of the North Ore Body is partly flooded and water is pumped up to a small reservoir located in the Lower Quartzite of the North Ore Body. Water is pumped from this area to the service adit and thence to the tailing impoundment via a pipeline.
- The South Ore Body is partly flooded but the water level is self regulating, rising in the spring runoff or rainfall and then discharging back to groundwater.

The other major source of groundwater is the service adit opening. Considering the adit from the top down, the upper third is largely dry and is possibly located above the current phraeatic surface. About a third of the way down, water can be seen dripping out of the vertical joints and occasionally flows very freely out of the joints. An especially heavy inflow occurs in the conveyor tunnel at the transfer station. At this location the tunnel bends and crushed ore is transferred between conveyors.

Data are available on the pumping rates within the mine and on the flow rates into the pipeline running to the tailing area. These data were not inspected, however, the total underground working outflows run in a 10 inch pipe and likely are in the order of 1300 USGPM. The flows are seasonal and reports suggest that there is a strong groundwater inflow response to surface precipitation and snow melt. Peak inflow to the workings may be as high as 4000 USGPM

Based on discussions and data, which were briefly inspected on site, the water quality from the mine workings appears to meet guidelines for discharge to groundwater, however, copper levels exceed the guidelines for surface water discharge. The underground mine host rock was reported to be non-acid generating. Recent copper content at the tailing area was measured as 0.10 ppm.

## 3. TUNNEL PLUG OPTIONS

#### 3.1 General

As a general observation it is considered that the host Quartzite rock is an excellent material for supporting a tunnel plug. Careful selection will be needed to avoid jointed or faulted zones at the plug locations, however this does not appear to be a significant problem.

As discussed later it is assumed that concrete tunnel plugs will be used. The concrete tunnel plug length will be determined by the rock quality at the plug location, however, it will likely be in the range of one tenth to one fifteenth of the maximum water head retained. Thus, if the maximum head is 100 ft, the plug length might be about 10 ft. The plug location will need to consider rock cover. The shortest distance from the plug to the unweathered rock surface, taking into account the sloping ground surface, will need to be equal to the maximum water head against the plug.

Plugs can be constructed internal to the mine workings to seal off heavy water inflows from mined out areas. This is effective if the water inflow is from many sources, which then report to a single adit, however if the water inflow is from a single source within the workings then it may be more cost effective to grout off the inflow.

A plug will likely be constructed across the service adit, at the Troy mine it is understood that if pumping were stopped and no plug was constructed, all water would eventually flow out from the service adit. Hence a tunnel plug across the service adit could cut off or significantly reduce outflow reporting to surface waters, provided there are no other opening such as an ungrouted drill holes or a highly permeable fault zones below the subsequent flooded mine phraetic surface

Based on reported observations from exploration drill holes, the pre mining groundwater level in the mountain was at least 300ft below original ground level. It appears quite likely therefore that mine water could be retained in the workings by plugging the service adit. In this case the mine water will report almost entirely to groundwater. After installing the plug, the mine water level will likely fluctuate due to surface precipitation or snow melt and then subsequently reduce as the groundwater level drops. This appears to be the current condition in the south ore body

The mine derived groundwater may eventually report to the surface as springs, perhaps local to the mine. The probable locations of these springs and an assessment of the water quality at these locations will be needed to assess compliance with surface water quality criteria.

It may be considered desirable to use the tunnel plug as a means of regulating mine water outflow for the purposes of providing a consistent flow to the tailings area or another water treatment location if required. Alternatively, a fall back position may be desirable in case water quality to the groundwater or spring water becomes a concern. A concrete plug could be fitted with an outlet pipe controlled by a valve to regulate outflows or to regulate underground water levels, if desired, to control surface seepage. In our experience these types of regulated outlets will require maintenance and may need occasional replacement due to corrosion.

The location of the plug in the service adit will depend on a trade off between a number of factors, the closer the plug is to the portal, the higher the retained water pressure but the more adit water seepage will be intercepted. Consequently it will be important to assess the water quality in the seepages into the service adit as part of the tunnel plug location selection process

There are a number of alternatives to the use of concrete for tunnel plugs; low permeability plugs can be constructed from natural materials such as sand, drain gravel and bentonite. Alternatively flow through plugs can be built from sand with gravel drains. These types of plugs may be essential in acid environments where severe attack on concrete is likely. We understand that at the Troy mine acid generation is not likely an issue. DEQ favor the installation of a water regulating outflow pipe and this type of pipe is much more secure when seated in a concrete plug, therefore for current planning purposes we recommend that it is assumed that the plug would be built of concrete.

# 3.2 Conceptual Plug Design and Construction

Plug design and construction has the following components:

#### 1. Design

The initial design step would include the following checks:

- A review of the lateral and vertical rock cover and rock quality to prevent hydrofracturing.
- The plug is to be located in as good a rock mass as possible as the design must resist failure by hydraulic jacking, shear failure along rock/concrete contact or through rock, resist erosion and resist disintegration.
- The other issues to consider are the presence of diamond exploration holes, their whereabouts and characteristics as these can be a nuisance if they have not been sealed, are connected to the tunnel and extend to or near the surface.
- The site selection is also dependent upon the calculation of the correct water head felt by the plug. This should be based on the location of the highest final phreatic surface level of the water table, the grade change within the plugged area of the tunnel, as well as the location and characteristics of any large shear/fault structures which could act as conduits for water. This calculation will also have a significant impact on

the plug design dimension. Mapping of the tunnel area that is to be plugged will be required (just major structures).

One of the concerns for the preliminary plug design is the definition of water tightness. There will always be some seepage around the plug area and down stream of the plug. Therefore the first thing to consider is what are the regulations regarding seepage from the adit and what outflows could be treated by passive methods such as wetlands or lime additions into the underground.

The constraints on the "tightness" of the plug will also affect the cost of the plug. To obtain a "tight" plug, it has been our experience that extensive grout curtains and consolidation grouting may be required. This can be very time consuming and expensive.

Confirmation of the design will require some on-site detailed investigations in the vicinity (once identified) of the tunnel plug(s). The investigations will include confirmation of the plug location, and gathering information on the joint fabric and joint characteristics such as spacing, width and continuity, orientation, strengths and infilling. A minimum of three cored drillholes (NQ) will be required in the plug area to define rock mass conditions with depth, permeability with depth and to compete hydrofracture testing

Once the information from the investigations has been compiled, then modifications of the preliminary design can be completed. Some of the specific tasks at this stage will cover:

- Assessment details of construction methodology;
- Structural design of the plug;

Geotechnical design of the plug;

Preparation of design report and drawings;

Submission/presentation to government authorities; and

Preparation of the bill of quantities, technical specifications and construction drawings.

2. Construction Sequence

In general, there will be a "relaxed zone" that is present around the existing tunnel due to the redistribution of stresses as well as damage from blasting. This zone will generally provide higher permeability values and will therefore need to be grouted during the "consolidation grouting stage" prior to the plug pour. Grouting will also reduce the hydraulic gradient across the length of the plug and reduce the possibility of piping of joint infilling.

It will be important to define what cement products are required. Ordinary Portland cement can have too large a particle size which may not sufficiently seal fine cracks or joints. Microfine products may be required with additives to provide the proper viscosity and strength.

The plug pour will require a pump, batch plant and delivery system to the plug location. Bulkheads and a diversion pipe will be required. The plug should be poured at one time and not possess a cold joint.

After cooling of the plug, additional contact grouting will be required to fill and seal any cracks and spaces between concrete and rock contact. Directional drilling and again staged grouting will be required. Generally, the target areas are located prior to the plug pour and the drill set-up worked out. For estimation purposes, assume there will be a need for four rings of grout holes. Each ring will have 8 holes and average hole length of

PM 8925 01.500 001023R - Conceptual Tunnel Plug.doc 15 ft. Some holes will have to extend to the upstream end of the plug; some will be short and only extend to the downstream end of the plug.

A recent conceptual level cost estimate was carried out for a plug similar to the one envisioned for the Troy Mine service adit. Using the above design and construction stages, a low permeability plug built by an outside contractor was estimated to cost about \$250,000 US including all design, construction and QA/QC work.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

A site visit was made to the Troy mine by Klohn Crippen to help in the assessment of the use of tunnel plugs for closure to raise the flooded level in the underground and to control surface water flows from the underground workings. The rock quality and the mine geometry appear well suited to construction of one or more plugs to significantly reduce the pit water flow reporting to the surface water collection area at the exit of the service adit. An understanding of the groundwater regime at the mine is needed to assess the implications of raising the water level in the underground. The locations of possible seepage areas need to be identified to assess the fate of the groundwater discharge from the underground. Plug design needs to be integrated with the hydrogeology of the area to optimize the cost and benefit of various plug locations and alternatives for the groundwater management.

It is believed that good use can be made of internal plugs or grouting to reduce surface water outflow from the underground either during operation or on closure.

As requested Klohn Crippen are preparing, under a separate cover, a proposal for the next stage of the assessment of the tunnel plug and underground water control.

Yours truly,

KLOHN CRIPPEN CONSULTANTS LTD.

Len Murray, P.E. (Washington)

Project Manager

Harvey McLeod, P.Eng

Reviewer

# **REFERNCES**

IRSM: International Society for Rock Mechanics (1977). "Suggested methods for the Quantitative Description of Discontinuities in Rock Masses", *Int. J. Rock Mech.*, Mineral Sciences and Geomechanics Abstracts, 15, pp. 319-368.

# APPENDIX I October 12 Meeting Notes

#### **MEETING NOTES**

**LOCATION:** Troy Mine Site, October 12, 2000

PRESENT: Len Murray (Klohn Crippen) Doug Parker (ASARCO)

Joe Gurrieri (DEQ)

Peter Werner (DEQ)

Patrick Plantenberg (DEQ)

Scott Mason (Hydrometrics)

Jamie Poell (Hydrometrics)

Dean Culwell, (Westech)

Warren McCullough (DEQ) Bruce Clark (Genesis Inc.)
Kris Newgard (Kootenai NF) Dave Young (Sterling)

John McKay (Kootenai Forest)

PURPOSE: To discuss issues related to re-opening and subsequent closure of

Troy Mine.

**RECORDED BY:** Len Murray, Klohn Crippen (a member of the Louis Berger Group)

This document is intended to provide a summary of the notes made by Len Murray. They do not necessarily cover all the points discussed and are intended for information purposes only.

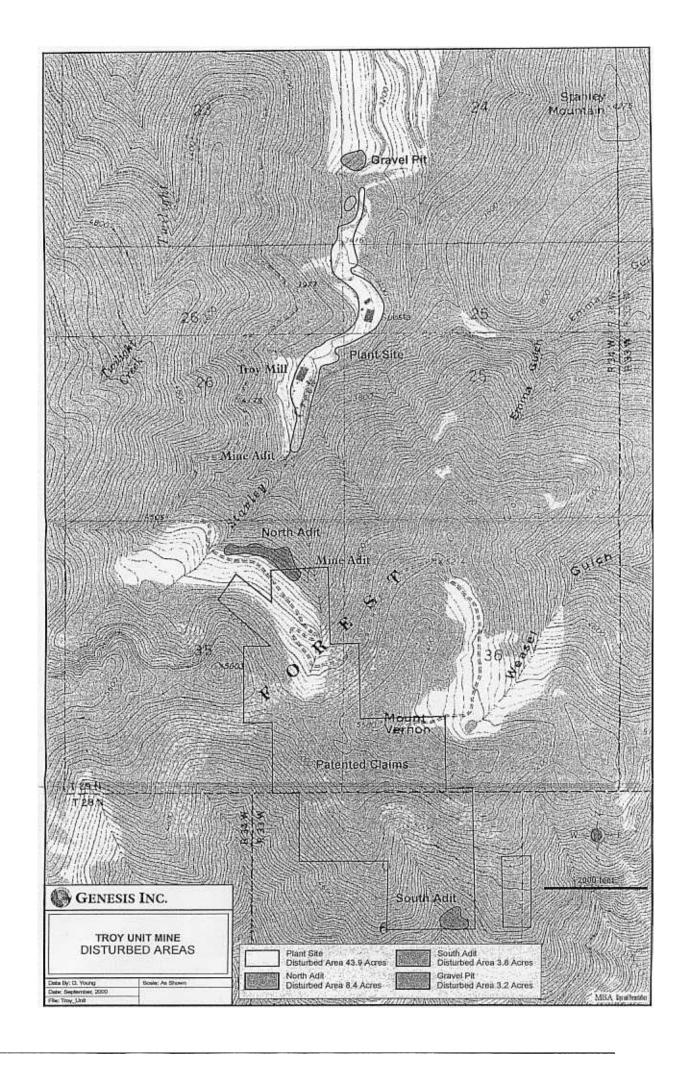
ITEM	DESCRIPTION	ACTION
Tailings Area	Hydrometrics gave an overview of their work and subsequent discussion included the following:	
	Hydrometrics are undertaking soil and vegetation studies and have dug some test pits in borrow areas and topsoil stockpile for sampling.	
	A reclamation plan would be needed if the borrow area near the mill is developed.	
	There is not enough topsoil stockpiled at the tailings dam area to provide 18" of cover. Sterling estimate they are 40% short.	
	DEQ indicated that there must be 18" of average cover, but this could be made up of thicker subsoil (sand and gravel) and thinner topsoil.	
	There may be additional borrow near Lake Creek but Sterling do not wish to disturb the Lake Creek river bank due to stability concerns.	
	<ul> <li>Sterling wish to leave the toe ponds between the dam and Lake Creek for aesthetic and wildlife values. The ponds are not considered to affect stability but leaving them could reduce the recoverable quantity of topsoil.</li> </ul>	
	A revised plan is needed for borrow sources.  DEQ need to be able to demonstrate that what is proposed is equivalent to the old proposal.	**

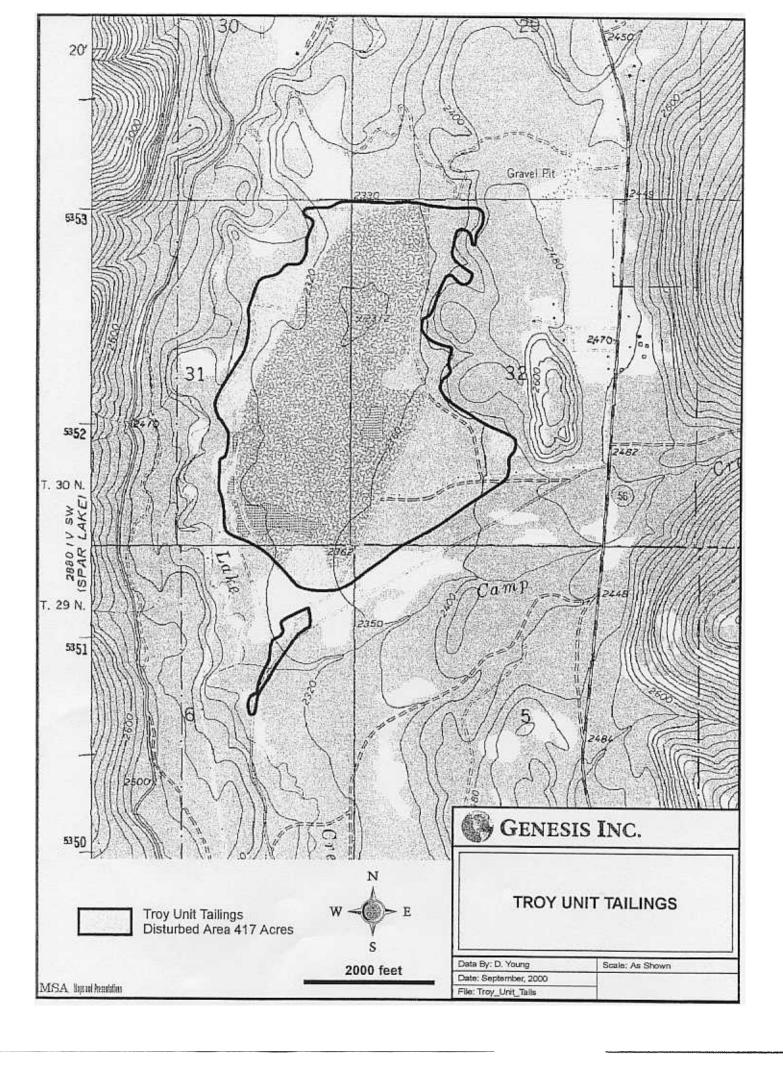
ITEM	DESCRIPTION	ACTION
	Noxious weed is a concern and a control program is needed.	
	It was generally agreed that preference be given to revegetation with native species for persistent varieties. Non natives could be used for emergency e.g. erosion control.	
	<ul> <li>The mill site has much steeper topography and has rock portions. Using soil cover does not make sense on steep slopes.</li> </ul>	
General Issues	<ul> <li>Sterling requested clarification on what is required by the Regulators to allow mine re- opening.</li> </ul>	
	DEQ feels that water is the major issue due to the costs of having to treat in perpetuity.	
	• DEQ need to limit uncertainty or compensate by requesting a larger bond. They need an application before they can give a ruling. If a plan were received Dec. 21, 2000, DEQ could recalculate the bond by Jan. 31, 2001. A completeness study could take one year and an environmental analysis with water treatment could take three years. It may be possible to consider a five-year interim bond while other	
	<ul> <li>processes are in progress.</li> <li>A very important concern is leakage from the tailings area.</li> </ul>	
	• Forest service needs a letter of intent to reopen. Their issues are not as problematic as DEQ, since DEQ will eventually "own" the mine and the tailings.	
	DEQ requested a conceptual model for water treatment.	•
Underground	The Discussion included the following:	
	If openings are plugged, what will be the fate of the water and what will be the water quality in the flooded workings.	
	What is the water quality going into the mine and what is the background water quality.     There is no background data available.	
	The South Ore Body is a leaking area, what is the water quality when this breaks to surface and where does it break.	
	There may be some slope failures occurring related to mine seepage water.	

ITEM	DESCRIPTION	ACTION
	If plugs are used to control mine water, then alternatives for multiple plugs, different plug locations etc. need to be considered.	
	<ul> <li>Portal plugs with controlled outlets (e.g. pipes with valves) could be used to regulate the flow to the tailings area/treatment plant.</li> </ul>	
	Water quality is the main issue.	•
Plant	DEQ cannot include salvage value in bond calculations, they will assume an offsite haul.	
	The Forest Service may request removal of asphalt from the main access road; this could be a major cost.	
	Powerline; a letter from the utility would be needed with a bond for any remaining spur line.	
	The fate of asphalt on the access road needs to be agreed.	- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1
	Demolition costs are a major component of bonding, water treatment is the other big issue.	
	If the underground workings are plugged residual flows could possibly be treated by a wet land at the plant.	
	Sterling are proposing to eliminate a lot of recontouring from the 1978 plan but are aware that they need to convince DEQ of the merits of this approach.	
Water Quality	Hydrometrics presented some of the water quality monitoring data.	
	Data are available on the underground water quality and the service adit ditch water quality. These data have not been reviewed in detail but meet criteria for groundwater discharge.	
	Groundwater inflow and outflow need to be characterized.	•
	The water quality does not meet surface water discharge quality criteria, mainly related to copper.	
	Area 9 East could be plugged off and this would reduce the inflow quantity.	
	There are a number of other areas such as the conveyor transfer station that could be grouted off to reduce water handling.	
	Water quality at the tailings area was discussed.	

ITEM	DESCRIPTION	ACTION
	Currently copper in the water discharged from the tailings ponds does not reach to the groundwater. The attenuation mechanism for copper is not known and it is the only element which shows this attenuation.	
	A model is needed to explain copper attenuation, will there be an eventual breakthrough or is this an inexhaustible process.	
	There were some water quality issues during operation, with nitrates and nitrites in addition to copper.	
	There was extensive discussion about varying water sampling locations to get more meaningful and representative samples.	

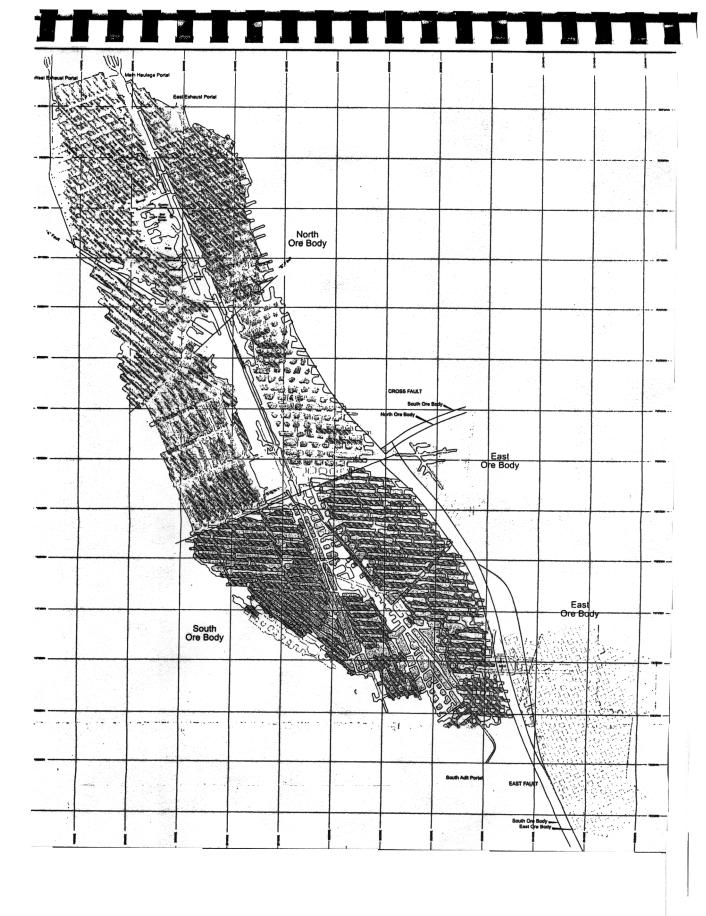
All parties toured the tailings area after the meeting.





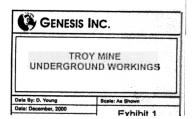
# **APPENDIX II**

Plan of Underground Workings Troy Unit Mine Disturbed Areas Troy Unit Tailings



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## LIST OF EXHIBITS

EXHIBIT A TROY MINE FACILITIES CURRENT STATUS

EXHIBIT B TROY MINE LAND STATUS

EXHIBIT C TROY MINE FACILITIES RECLAIMED STATUS

EXHIBIT D TROY MINE UNDERGROUND FACILITIES

EXHIBIT E TROY MINE TAILING FACILITY SITE PLAN & CROSS

SECTIONS

EXHIBIT F TROY MINE FACILITIES RECLAMATION & CLOSURE